Technical Memorandum

Florida Department of Transportation Hurricane Response Evaluation and Recommendations

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Version 5

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[1] A complete printout of all questionnaire responses received is available upon request from the ITS Section of the FDOT Traffic Engineering and Operations Office (TEOO).

List of Acronyms

AM ..... Amplitude Modulation
ATIS ..... Advanced Traveler Information System
CCTV ..... Closed-Circuit Television
CNN ..... Cable News Network
DMS ..... Dynamic Message Sign
DEOC ..... District Emergency Operations Center
DOT ..... Department of Transportation
DTOE ..... District Traffic Operations Engineer
EAS ..... Emergency Alert System
ERN ..... Everglades Radio Network
ESMR ..... Enhanced Specialized Mobile Relay
FCC ..... Federal Communications Commission
FDEP ..... Florida Department of Environmental Protection
FDOT ..... Florida Department of Transportation
FEMA ..... Federal Emergency Management Agency
FHP ..... Florida Highway Patrol
FHWA ..... Federal Highway Administration
FIHS ..... Florida Intrastate Highway System
FM ..... Frequency Modulation
FMS ..... Freeway Management System
FSITE ..... Florida Section Institute of Transportation Engineers
FTE ..... Florida's Turnpike Enterprise
GPS ..... Global Positioning System
HAR ..... Highway Advisory Radio
I-10 ..... Interstate 10
I-275 ..... Interstate 275
I-4 ..... Interstate 4
I-75 ..... Interstate 75
I-95 ..... Interstate 95
ITMS ..... Integrated Traffic Management System

ITS..... Intelligent Transportation Systems
ITSFL.....Intelligent Transportation Society of Florida
LED..... Light Emitting Diode
MHz ..... Megahertz
MOT..... Maintenance of Traffic
MPH.....Miles Per Hour
PIO .....Public Information Office
PTT .....Push-to-Talk
RWIS.....Road Weather Information System
SEOC ..... State Emergency Operations Center
SR..... State Road
STAT.....Signal Technical Advisory Team
SZ..... School Zone
TEOC .....Transportation Emergency Operations Center
TEOO..... Traffic Engineering and Operations Office
TiRN™ ..... Traveler Information Radio Network™
TMC..... Transportation Management Center
TV .....Television
U.S. ..... United States
VOIP ..... Voice Over Internet Protocol
WIM.....Weigh in Motion

1. Introduction

The 2004 hurricane season will be remembered as the year an unprecedented number of hurricanes hit Florida. In a turbulent span of seven weeks, Florida was rocked by four separate hurricanes – Charley, Frances, Ivan, and Jeanne. The storms made landfall on all three sides of the Florida peninsula and together caused an estimated $41 billion in property damage throughout the state.

Along with catastrophic losses to homes, businesses, and communities, significant damage occurred to Florida's transportation infrastructure. Examples are many. Thousands of traffic signal heads were broken or lost altogether. Power lines were down at intersections and streets were flooded. Tidal surges undermined sections of coastal highway pavement. Several sections of the Interstate 10 (I-10) bridge over Escambia Bay were swept away. Highways were littered with the remnants of road signs, and damaged or destroyed light poles.

To document the responses to these hurricanes and to make recommendations for future hurricane preparation, handling, and recovery practices, the Florida Department of Transportation (FDOT) decided to review 14 different areas under the direction of the Traffic Engineering and Operations Office (TEOO). The FDOT will use this effort to evaluate various District and the Central Office activities before, during, and after these major storm events.

With this intent, the TEOO prepared questions that covered the following areas:

1) General information
2) Signal operations
3) Expectations for signal restoration
4) Mast arm, span wire, and signal equipment issues
5) Power outages and generator use at signalized intersections
6) Maintaining traffic on evacuation, reentry, and diversion routes
7) Road Rangers
8) Transportation management center (TMC) operations
9) Intelligent transportation system (ITS) field devices
10) 511 operations
11) Web site operations
12) Dissemination media
13) Microwave systems, and communications between cell telephones and radios

The questions developed were divided among the Central Office ITS administrators responsible for each of these areas to gather information from various District personnel. The remaining questions were sent directly to the Districts for their responses, as appropriate.[2] The replies were compiled and the information subsequently reviewed to identify the most effective hurricane plans and response efforts. The study team also looked for observations from the Districts on various emergency management activities, along with any recommendations that could be made that would form the basis for more practical, effective hurricane response in the future.

[2] To review all of the questions distributed and referenced herein, refer to *Appendix A*.

2. General Overview

Thanks to the efforts of District staff throughout Florida, the FDOT's hurricane response and recovery work helped keep many vital transportation facilities functioning during the storms, and quickly restored others to full operation once the weather had cleared. There was close cooperation with local governments; law enforcement; other state agencies; and providers of emergency aid and assistance. Florida's emergency preparedness planning was put to the test when successive hurricanes struck the state, including some parts of Florida that were still recovering from the previous hurricane. As devastating as the ordeal was for much of Florida, the events of August and September provided an opportunity in which disaster planning, response, and recovery were thoroughly tested under actual conditions – the worst weather scenario Florida may ever encounter.

This report seeks to document the results of that testing. It presents the information obtained from District Traffic Operations Engineers (DTOEs) and their staffs on how their plans and efforts worked; which actions turned out to be most effective; and what unexpected problems should be addressed to better prepare for future hurricanes. A summary of each study area's findings are given in *Section 3* for those transportation professionals with interest in particular subjects.

Section 4, *Florida Department of Transportation Trends in Hurricane Response*, summarizes the common practices employed around the state by the Districts. It highlights the application of systems, equipment, and technologies to the problem of effective emergency response on a wide scale.

In *Section 5*, recommendations are provided that should be examined further and considered for future application in hurricane response plans and operations.

Section 6 outlines decisions made by the FDOT at the DTOEs-FACERS-FSITE-ITSFL Meeting held on January 27, 2005, in Miami, Florida. Based on the findings in this report and extensive FDOT staff discussions, the Central Office TEOO will develop a Hurricane Plan to guide future preparation, response, and recovery operations. *Section 6* also describes certain policy statements for signalized intersections that were agreed to at the January 27 meeting by the attendees.

2.1 Hurricane Timetable Summary

The first of the four storms, Hurricane Charley, made landfall at Cayo Costa, a barrier island just west of Cape Coral, on Friday, August 13, 2004, at approximately 3:45 p.m. The Category 4 hurricane had sustained winds of 120 miles per hour (mph) and delivered a 7-foot storm surge in Fort Myers as it came ashore. Charley moved over the Orlando area at about 9:00 p.m. and exited into the Atlantic northeast of Daytona Beach at about 1:00 a.m. on August 14. According to the State Emergency Operations Center (SEOC), Charley was the strongest hurricane to make landfall in the state since Hurricane Andrew in 1992. Moving north-northeast at 25 mph, Charley traversed the Peninsula in 9 hours.

Hurricane Frances came ashore on Sunday, September 5, 2004, near Jensen Beach at approximately 1:00 a.m. The Category 2 storm arrived with sustained 80-mph winds, crossed Martin County, and moved through Florida, exiting the state near Tampa late on September 5. At that point, the National Weather Service downgraded the hurricane to a tropical storm. Frances traveled across the northeastern Gulf of Mexico and made landfall again in the Panhandle near St. Marks on Monday, September 6, at approximately 2:00 p.m. While Charley will be remembered for wind damage, Frances' primary impact was flooding, with storm surge on the Atlantic Coast near Vero Beach of 8 feet. Volusia County reported the highest rainfall amounts, ranging from 10 to 14 inches. By September 9, virtually every river in southwest and west central Florida had flooded.

Hurricane Ivan made landfall on Thursday, September 16, 2004, in Gulf Shores, Alabama, at approximately 2:00 a.m. A Category 3 hurricane, Ivan had sustained winds at landfall of 90 mph and spawned numerous tornadoes as it moved inland. Escambia and Santa Rosa counties reported record storm surges that caused tides 10 to 15 feet above normal. Widespread beach erosion and coastal flooding added to the damage. Pensacola had the highest rainfall amounts – up to 16 inches in the area. Ivan crossed Alabama and traveled north into Virginia. It then turned south, making a big circle back through central Florida as a low pressure system beginning on September 20. The system exited the state north of Tampa on September 22 and regenerated into a tropical storm, striking Louisiana on the evening of September 23.

Hurricane Jeanne came ashore on Saturday, September 25, 2004, at approximately 11:50 p.m. on Hutchinson Island east of Stuart. A Category 3 hurricane, Jeanne had sustained winds at landfall of 85 mph, but much of the intense rain bands and winds were felt up to two hours before the storm arrived. The strongest tidal storm surges (ranging from 6 to 8 feet) were recorded in a stretch from southern Brevard County south to Martin County, though the impact was lessened because it was low tide when Jeanne came ashore. Brevard and Osceola counties had the highest rainfall amounts at 11 to 13 inches. The hurricane moved through central Florida and then swung north as it approached Pasco County. Jeanne left the state late on Sunday, September 26, as a tropical storm, passing north through Valdosta, Georgia.

3. Study Areas

This section presents the detailed information that the Districts provided regarding traffic operations in areas that were affected by the hurricanes and how District personnel responded to the various problems encountered.

3.1 Signal Operations

Each District affected by any of the four hurricanes reported difficulties with signal systems. Part of the hurricane response evaluation focused on signal system preparations for the hurricanes and the systems' return to operation after the storms.

One of the main topics to develop out of the signal operations discussion was the removal of signal heads before the hurricanes' arrivals as a means of protecting the devices and lessening the damage sustained at intersections. Of the seven Districts impacted by the storms (the Turnpike doesn't have signals), signal heads were removed in three Districts in advance of the hurricanes. The Districts that did not take this precaution gave several reasons for their decision:

- Potential liability should an incident occur when a less than standard number of signal heads were present at the intersection
- The unpredictability of the hurricanes' landfalls
- Problems associated with storing, labeling, and reattaching the removed heads
- The rush to make repairs after the storm, when some signals presumed missing could be mistakenly replaced if the contractor was unaware that the signal heads had been removed and stored

Of the three Districts where signal heads were removed, District 4 took down approximately 1,200, and various local agencies in District 1 did the same, including Lee, Highlands, and Polk counties, and the City of Lakeland. District 7 said only one of its maintaining agencies removed signal heads, while another did not because of the liability concern noted above.

District 1 said they will certainly continue to consider the value of signal head removal. "Our experience with the recent hurricanes taught us about the unpredictability of the storm path. In addition, we observed many locations where drivers were confused where signal heads had been removed and only one remained," they noted. This was particularly true on multilane roads that had intersections with protected left or right turn lanes and two through-lane signals.

The other two topics of discussion under this section were traffic signal coordination and power consumption. Coordination revolved around whether the Districts maintained coordination during and after the hurricanes and, if so, how it was maintained. The general response to maintaining coordination was affirmative – it was maintained at least after the hurricane, if not during it. This was done using the interconnect cable or, if that was damaged, using time-based coordination, as appropriate.

The electric power issue was centered on whether to operate intersections with fewer signal heads to reduce power consumption. This was done solely in District 7, which only instituted this practice at intersections with generators.

3.2 Expectations for Signal Restoration

As noted in questionnaire responses, the main problems that hindered efforts to restore traffic signals were damaged brackets, lack of signal heads, and loss of electric power. Another consideration in the recovery effort was which intersections to repair first. In general, the Districts agreed that county road signals were just as important a priority as state road signals. Signal prioritization for restoration to service should be conducted without any preference given to the signal ownership. At District 3, where the entire Escambia County traffic signal system had to be restored, questionnaire respondents noted that any prioritization for signal restoration is going to be dynamic, based on damage in the area, whether power is available, the condition of the roadways, and other variables. That said, the main criterion Districts used to prioritize intersections for signal restoration was traffic volume.

The Districts noted all of the following unexpected problems in their efforts to restore signals: assessing initial damage and progress during restoration efforts; problems with generators used in the restoration due to lack of fuel and communications; theft of the generators in service; controller cabinet locks being changed by local agencies that did not provide keys to the FDOT; and the need for passwords once repair crews had access to the controllers.

One of the difficulties that District 1 Traffic Operations encountered early on was the number of staff members unavailable because of storm damage to residences, or personnel not being able to travel to work. “Three storms in such a short time period put a great deal of stress on both the individuals who reported to work and also to a greater extent the people who received damage to their personal property,” District 1 reported. They had to get by with those employees who were able to report to work, supplementing that workforce with assistance from other offices.

3.3 Mast Arm, Span Wire, and Signal Equipment Issues

This section addresses the impact of the hurricanes on the signal equipment itself and the durability of the two main signal designs deployed in Florida – mast arms and span wire-strain pole assemblies.

Table 3.1 – Traffic Signal Statistics

District	Total No. of Signals District-wide*	Total Signals on the State Highway System	Total Signals on Local Roads	Total Mast Arm Signals District-wide*	Total Mast Arm Signals on the State Highway System	Total Span Wire Signals Districtwide*	Total Span Wire Signals on the State Highway System
1	1,778	981	797	802	432	976	542
2	1,585	1,125	460	537	437	1,048	688
3	987	687	300	300	280	687	407
4	3,329	1,778	1,551	1,180	1,062	2,149	1,165
5	2,972	1,479	1,493	458	325	2,514	1,154
6	2,640	1,341	1,299	1,848	938	660[3]	403
7	2,151	1,018	1,133	518	263	1,633	755
Turnpike	None			None		None	
Total	15,442	8,409	7,033	5,643	3,737	9,667	5,114

* Totals include signals on the state highway system and local roads.

[3] District 6 also has 132 pedestal-mounted signals.

Table 3.2 – Traffic Signal Damages

District	Mast Arm Structural Damage	Signalized Intersections that Sustained Damage *	Signals Inoperable Due to Power Outage	Losses Due to Cabinets Submerged or Flooded	Total Affected Intersections for all Four Hurricanes
1	2	496	138	0	636
2	0	40	226	0	266
3	2	265	300	15	582
4	14	735	2,664	0	3,413
5	2	1,885	2,507	2	4,396
6			No Damage		
7	0	102	1,500	0	1,602
Turnpike			(Florida's Turnpike has no traffic signals.)		
Statewide Totals	20	3,523	7,335	17	10,895

* Damage can be defined as signal loss due to failure of the span wire, bracket assembly, mast arm mounting hardware, or other components.

Of the losses noted, the main cause was bracket failure, with general span wire failure being a close second and mast arm failure (i.e., failure of the structure itself) being a very distant third. In addressing the bracket failure, only two Districts reported which brackets their maintaining agencies preferred: District 4 indicated Engineered Casting and District 5 indicated both Engineered Casting and Cost Cast.

Again, power outages were noted as a major impact of the hurricanes in all of the Districts. The number of signals per District initially without power ranged from 272 in District 1 to approximately 2,664 in District 4. Flooding of cabinets, surprisingly, was not a major factor in making signals inoperable, with only 2 cases reported in District 5 and 15 cases in District 3.

In discussions regarding mast arms versus span wires and strain poles, the overwhelming design preference is mast arms, which Districts said have proven to withstand hurricane conditions better than span wires and strain poles. District 5, however, did offer an observation about signal replacement, stating they "believe our mast arm policy is sufficient, as it covers the coastal area. One thing we learned is that we can restring [span wire] signals quickly and the cost is low. In areas where we lost mast arms, we had to set poles and string up signals and are still waiting on reinstallation of the mast arms (maintaining agency handling). We lost some heads that were attached to mast arms and many times we had to readjust signals that were twisted. This work was completed by our contractor(s) as they were progressing through the corridors."

As for preferences regarding horizontal or vertical mounting on the mast arms, only District 4 offered an opinion on the issue, stating they preferred vertical mounting because it is easier to maintain.

Districts were divided about whether there was any benefit to powering school zone (SZ) equipment through solar power instead of a regular electrical service. Two respondents saw a benefit in the ability to maintain power for operating the devices, though another questioned whether solar power is worth the higher initial cost and additional upkeep for the maintaining agency. If the school at that location is closed anyway due to a power outage, a solar-powered SZ sign is a moot point.

Review of the damage at intersections following the four hurricanes provided ample evidence that the method of installing traffic signals using span wires, strain poles, and hanger devices was insufficient in most cases to withstand the high wind speeds experienced. As the signal head swings in the wind, the span wire messenger cable puts stress on the hanger and eventually the assembly fails. It has been determined that a new hanger design is needed to correct this problem. This recommendation is included in *Section 5*.

3.4 Power Outages and Generator Use at Signalized Intersections

All of the Districts affected by the various hurricanes experienced power outages at their signalized intersections or with their ITS field devices. In response, more than 650 generators were purchased either by the Districts themselves or the Central Office for placement at critical intersections to restore power and facilitate traffic flow after the hurricanes, and to provide power for some ITS field devices in District 5.

While solving the immediate power problem the storms created, use of the generators raised issues of their own. There were difficulties in placing the generators at intersections with traffic signals out, and also in connecting emergency power sources to the signal systems. Crews placing generators reported that many signal systems were not designed to easily accommodate an alternate power source beyond commercial electricity.

Another problem was keeping the generators secure against theft. All the Districts who deployed generators experienced at least some difficulty with the units being stolen, despite taking such measures as chaining them to the signals.

Refueling was a challenge; the generators only run for a limited time and required refueling every six to eight hours on average. Commercial fuel was not available in all areas and the manpower necessary to refuel so many generators three or four times per day was significant. Even finding some of the generators to refuel was difficult because the signal contractors that were working around the clock to restore power at intersections were moving the generators to other nonworking locations.

While these challenges – together with the generators' purchase expense, maintenance, refueling, and theft protection – were significant, overall, the generators were a great help to the Districts and should be used again in similar circumstances. However, plans for their use and possible signal design changes need to be implemented.

3.5 Maintaining Traffic on Evacuation, Reentry, and Diversion Routes

In general, the Districts were not involved in developing routes for evacuation, reentry, or diversion of traffic. Rather, they worked to remove or to ensure the removal of construction maintenance of traffic (MOT) on all evacuation and reentry routes, based on the FDOT's policies, and to get signalized intersections operating on these reentry and diversion routes.

Some of the Districts indicated that access management was implemented on a limited basis and was handled by local agencies. In District 7's case, they extended their Road Ranger operations to the arterials that were also evacuation routes. How well these routes functioned received mixed reviews, based on the damage sustained by the routes during the hurricanes. For example, in District 3, the reentry routes were poor after Hurricane Ivan because they had been so severely damaged. There, the detour route designated was changed two or three times, at one point even passing through Alabama. District 3 had to repair three signalized intersections in Alabama and supply them with generators. Because the detour route intersections were a priority repair, this caused intersections in the busier southern end of Escambia County to go longer before signal operations were restored. One remedy for this situation may be to let Districts decide the detour routes.

Districts 3, 5, and 7 all had plans to maintain traffic flow on evacuation and diversion routes, and put these plans into action. These plans included the repair of washouts and construction areas; the deployment of road assistance vehicles, including but not limited to the Road Rangers; advance dissemination of traveler information; temporary traveler call centers; access management; and generator-powered signals at intersections. District 7 reported no major incidents in connection with their efforts and no stranded motorists.

Following Hurricane Ivan, District 3 said their signal contractors were able to repair signals expediently on reentry routes. Local law enforcement did a good job controlling critical intersections during the initial signal reconstruction effort. Initial clearance of roadways in and out of the District by FDOT maintenance teams went well.

In District 5, "Our maintenance forces did an excellent job in clearing the routes and bringing them back into full operation. Along with that, the police did a good job in working the critical intersections until we could get them back online," they said. The same was true in District 1.

For the reentry routes to work better, District 7 recommended an increase in road service coverage. Where traffic lights were inoperative, District 7 favored having a large inventory of generators to provide power along these routes to keep the traffic lights functioning on the connecting roads and to relieve the interstate system.

Dissemination of motorist information is a crucial part of evacuation/diversion route success. Districts tended to use as many outlets for these bulletins as they could identify. District 1 kept media outlets updated on road conditions and repair progress through the District Public Information Office (PIO). District 3 made use of highway advisory radio (HAR); portable message signs; local radio and television (TV); posters and flyers at truck stops; weigh-in-motion (WIM) stations; and rest areas. Florida's Turnpike Enterprise (FTE) used dynamic message signs (DMS), HAR, and PIO advisories released to the media. In District 5, information was shared primarily through various media outlets. District 5 also used 511 and DMS, including portable DMS, in cases where they had roadways closed or there was significant damage. District 7 relied upon the close working relationship between the FDOT and the news media, plus the emergency operation centers (EOCs) in each county – all of which provided information to the public. Local radio stations in District 7 joined TV stations in broadcasting this information before, during, and after the storms. That meant that those citizens using battery-operated radios were getting the same information as those capable of receiving information from TV broadcasts.

In preparation for future hurricanes, Districts indicated that they would have on hand portable message signs; stop signs; barricades; satellite telephones; global positioning system (GPS) units; large pickup trucks for towing and hauling; and at least one four-wheel-drive passenger vehicle at each field office, plus chain saws, pumps, generators, and fuel. District 5 favored stocking up on a limited number of generators for key locations and extra signal hardware, though not necessarily signal heads. District 7 listed generators, water, and ice. Food would be next. There are other items to consider, but these were the items in greatest demand in any area where the storms hit the hardest.

Flooding in various locations was a problem during and after the hurricanes, and this had the potential to interfere with traffic movements. District 5 employed pumps on some routes during reentry to reduce the flooding along roads. District 7 reported that only one causeway that was used as an alternate evacuation route flooded. This occurred when rivers crested several days after the storms, and flooding conditions persisted for several hours. Before the storms, the bridges were announced through the news media as not passable. The damage afterward was minimal.

In District 5, personnel did nothing out of the ordinary for flood response that they didn't already have in place. Flooding turned out to be limited, and it occurred in different places with each event due to the varying nature of the hurricanes and their rainfall patterns. In addition, the impact from the rising St. Johns River was not felt until a week or so after the storm.

District 7 relied on a vigilant watch by their road service units, and there was some flooding reported each time a hurricane passed through. Personnel monitored the drains along the evacuation, reentry, and diversion routes to ensure that they were free from obstructions to prevent flooding.

Districts utilized a number of other tools to maintain traffic flow on evacuation and diversion routes. Road Rangers were reassigned to other areas to assist motorists who were out of gas or broken down. Special attention was given to locations on the roadway system susceptible to travel lane impediments, such as construction zones, and points where pavement was washed out and being repaired. After the hurricanes, there was an emphasis on the continued dissemination of travel information through media outlets, EOCs, and other avenues. Police and the Florida Highway Patrol (FHP) assisted in maintaining traffic flow while repair crews reestablished electric power at critical intersections.

3.6 Road Ranger Operations

The hurricane preparations that Road Ranger operations performed in most Districts included plans for reorganizing staff and limits on patrols in case it became necessary, and either purchasing additional fuel or arranging for the Road Rangers to utilize the FDOT maintenance facilities for refueling. The Road Ranger operations' contractors performed routine maintenance on their vehicles, and stockpiled such supplies as motor oil and transmission fluid. Once a hurricane's landfall was apparent for an area, plans were implemented to ensure that the maximum patrol area was covered by the maximum number of Road Rangers. Some Districts extended service hours on an as-needed basis; others went to 24-hour-per-day operations and hired additional personnel to make certain that their systems were covered. In District 7, for example, this included extending the patrol area to cover nonlimited-access roadways and critical evacuation routes, such as State Road (SR) 60. Districts 5 and 6 also extended their patrol limits, with District 6 covering United States (U.S.) 1 in the Keys and on the mainland because of the highway's evacuation route status, and District 5 covering more portions of Interstate 95 (I-95).

Beyond these preparations, Road Ranger contractors either followed their existing procedures regarding internal meetings or held meetings as necessary to keep their staffs briefed on the evacuation situation. Most Districts coordinated with the FHP, the local EOCs, and the SEOC, relaying information about extended hours and enlarged coverage areas, as well as general evacuation information. District 7 went so far as to assign their Road Ranger Coordinator to the Clearwater EOC during Hurricane Charley. This coordination worked well for the Districts and the partner agencies reported to the Districts that they were pleased with the coordination efforts, too.

During the evacuations, the actual hurricanes, and reentry, the Road Rangers were deployed in their usual manner to assist motorists, remove debris, provide fuel, and coordinate with the FHP as requested, which in turn facilitated evacuations and reentries. There was not a particular service the Road Rangers provided that could be singled out from the data received. The Districts reported that either stop counts were not available or the amounts only increased slightly during the evacuations and reentries.

All Road Rangers were pulled from the highways when winds created unsafe driving conditions or when the FHP left the roadways. They returned to service when winds dropped below the speed identified for unsafe conditions or when the FHP returned. While there was some belief on the part of a few contractors that services should have been stopped earlier and/or later, respectively, the majority felt that they were removed from service at the appropriate time to ensure their own safety and at the end of their effectiveness, since most motorists were off the roadways at that point.

As for Road Rangers providing assistance to other Districts, responses were split both in providing that assistance and in their capability to do so. Both District 2 and District 5 either provided assistance or were in a position to do so, but the FTE and District 7 did not or could not.

The main issues the Road Rangers noted were fuel shortages and communication problems. The main communication medium that the Road Rangers utilize is cellular service, such as Nextel®,[4] which experienced difficulties during the hurricanes. The FHP radios were also utilized in District 5 and these were noted as being more reliable than the cellular services. There were no redundant systems available to the Road Rangers, causing dispatching difficulties when the telephone and cellular systems were down.

3.7 Transportation Management Center Operations

During an emergency event such as a hurricane, a TMC can play a vital role in monitoring the state highway system and in disseminating information on the system to local agencies, neighboring Districts, motorists, and other necessary parties. This section provides details on how the TMCs throughout Florida achieved these goals.

3.7.1 Plans and Preparation

There are five Districts with active TMCs. Three other Districts plan to have operational TMCs in the near term (i.e., within two to five years). Of the operating TMCs, all had either formal or informal emergency plans in place that were activated in response to the hurricanes. The following section describes these plans, along with other preparations the Districts took with regard to TMC operations.

District 2's emergency plan included activities for extending Road Rangers' hours of operation and coverage both prior to and after the hurricanes. It also included a means for employees to communicate with each other, and assigned different responsibilities in order to cover TMC operations during the hurricanes. The plan worked well, especially since TMC operations allowed the District to disseminate information to motorists about evacuation routes and roadway conditions throughout hurricane events.

[4] Nextel is a registered trademark of Nextel Communications, Inc.

District 4 had plans for pre- and post-hurricane activities, such as securing or removing field devices; providing supplies (i.e., food, water, etc.) for TMC personnel; and identifying redundant power supplies for the integrated traffic management system (ITMS) prior to storm events. District 4's plans covered field assessment of equipment, relocation of the TMC if necessary, and a complete after-action report. At the Broward TMC, the plan was less extensive due to the fact that the devices being operated at that location are permanent. The post-event activities were very similar, with the only major difference being the development of a personnel checklist that allowed the FDOT to find and check the safety of its personnel. The plans worked well, especially the mobilization of the in-place maintenance contractors for damage assessment.

District 5 does not have a specific plan, but they do operate on a 24-hour-per-day, 7-day-per-week basis, which was continued during hurricane events. District 5 also created a backup center at their District Office so there would be redundancy in case the TMC went down. The plan was effective, but there were problems with power and a poorly performing backup generator, which have since been solved.

District 6's plan included keeping its TMC open on its normal 24-hour-per-day, 7-day-per-week schedule and allowing for shift changes a few hours prior to and after hurricane events. There were instructions for stopping Road Ranger services in District 6 when wind gusts reached 30 miles per hour (mph),[5] or stopping service 6 hours prior to the hurricane's expected landfall even if such wind gusts were not evident. The plan was effective.

The FTE's plan includes pre- and post-hurricane activities, such as procedures for remote operations, damage assessment, facility evacuation, and reopening of the facilities. The plan is detailed down to each position's role and responsibilities within the TMC. The plan was effective in allowing FTE to operate their two TMCs as a single unit, and keep them up and running on their usual 24-hour-per-day, 7-day-per-week basis.

[5] Districts followed different rules on curtailing Road Ranger services as wind speeds rose. Florida's Turnpike Enterprise ordered Road Rangers off the highway at wind speeds of 30 to 40 mph. District 5 issued the order at 35 to 40 mph. District 7's cutoff for Road Ranger services was a sustained wind speed of 45 mph. Service was resumed when winds dropped below those speeds.

Beyond the preparation outlined in the hurricane plans, the Districts also took other actions, including, but not limited to, meeting with various partners such as the FHP, FDOT Maintenance, the Road Rangers, and ITS maintenance contractors and operations consultants; creating new staffing assignments; bringing redundant TMC communication routes online; and canceling employees' personal leave time to ensure that there would be sufficient staff available for the TMC. They conducted reviews of the existing hurricane plans and provided motorists with information from ITS services that monitored evacuation routes and traffic conditions. Districts provided toll status; shelter and visitor bureau information (where more detailed shelter information could be found); and reported road conditions on DMS. They provided information to District emergency operations centers (DEOCs) and District management, and designated alternate routes, if warranted. These preparations enabled the Districts to ensure that the TMCs were in operation for the maximum amount of time possible, and ready to assist in keeping their personnel and the public safe.

3.7.2 Operations and the Hurricanes' Impacts

The hurricanes' direct impacts on TMC operations around the state were minimal. Some, such as District 4 and FTE, were required to operate their facilities from a remote location because of the storms' impacts on primary TMC locations. The ITMS was operated from the Broward TMC or remotely, and both the FTE's Pompano Beach and Turkey Lake TMCs were remotely operated for Frances and Jeanne. However, all the TMCs stayed operational, even if the facilities themselves were closed during the hurricanes, with the exception of District 2's TMC. The District 2 facility shut down completely and turned control of its system over to the FHP, which was not staffed for full operations. The decision to shut down a facility varied at each District, with the common concern being staff safety, and the usual cue being the close of Road Ranger and FHP field services. The facilities were brought back online using the same criteria; this usually meant that the facilities were back online as soon as the lifting of restrictions allowed them to be (e.g., the end of curfews), or the day after the storm had passed.

The TMCs' roles both leading up to and after the hurricanes included their normal operations of monitoring the state highway system and limited-access facilities, and providing information on these systems to the public using DMS and HAR. They also furnished information to other partners, such as adjacent Districts, counties, and 511 providers, as appropriate. Examples included DMS displays of tolls being suspended, hurricane shelter information, visitors' bureau locations, and providing alternate routes, if necessary. The major difference between pre- and post-hurricane operations was the need to assess damage and troubleshoot ITS services after the hurricanes to identify where devices or systems were down.

While the TMCs stayed operational during the hurricanes, in most instances this required increased hours or staff to handle the work. In most cases, some accommodation was made for providing the staff with food and shelter, if necessary. For example, at the FTE facility, food was supplied for staff members working extended hours. In District 6, the TMC has a cafeteria and showers, though staff was directed to bring their own drinking water.

The communication systems, including those from the TMC to the field devices and those between various personnel and agencies, were all affected in some manner. The most common concern was the loss of cellular communications prior to, during, and immediately after the storms, plus the public telephone systems going down due to damage or power loss. This hindered the TMCs' ability to communicate with internal personnel and with contractors, such as maintenance teams and Road Rangers. The field devices were also impacted in some of the Districts due to loss of power and damage to the fiber system.

3.8 Intelligent Transportation System Field Devices

Most all of the Districts have at least some ITS field devices deployed that they use to actively monitor the state highway system and limited-access facilities, and to disseminate information to the motoring public. The most common ITS equipment deployed are the usual freeway management system (FMS) devices, such as closed-circuit television (CCTV) cameras; fixed and portable DMS units; HAR; and several different types of detection devices. Of the Districts affected by hurricane events, all of them experienced at least some impact to their field devices.

As could be expected, the impact to each of the District systems was based in part on the size of the ITS deployed. For example, District 3 reported limited damage, but also noted that they have a very limited deployment of ITS devices. The most common types of damage the Districts noted were CCTV damage, communication system damages, and loss of power.[6] Other impacts, such as minor DMS damage (i.e., Lexan®[7] faces being pushed in and broken) in District 5, damage to field hubs in District 6, and HAR damage on Florida's Turnpike, were also reported.

Districts 2 and 5, and FTE, were the only Districts that reported having devices damaged beyond repair. Florida's Turnpike Enterprise reported the loss of two HAR beacon signs, and Districts 2 and 5 reported CCTV camera loss totaling over 17 units. This damage and most of the other actual damage done to the devices was attributed mainly to wind and water intrusion, with reports of lightning and power surge damages being next. There was no real pattern noted in the damage sustained by the Districts due to location, with the exception of increased damage to devices located closest to the coastline. This, too, was to be expected because hurricanes are at their greatest strength as they make landfall.

[6] The Turnpike deployed generators at some DMS locations before the storms in anticipation of losing power.

[7] LEXAN is a registered trademark of General Electric Corporation.

The average repair times reported for ITS devices ranged from two hours for CCTVs in District 2, to two to three days for DMS repairs. Restoring communication links and electric power to field devices often took longer, and some repair times were beyond the average noted when parts had to be ordered from manufacturers. The main delays in returning devices to service arose from the need to obtain spare parts, and waiting for those parts to arrive. When the Districts had spare parts – FTE had CCTV units on hand and replaced the damaged devices, typically within a week – they were able to make replacements much quicker than when ordering from a manufacturer.

Hurricane repair costs for ITS devices ranged from $9,548 in District 2 to $280,367 in District 5 due to the impacts from Charley, Frances, and Jeanne. Florida's Turnpike Enterprise reported costs of roughly $80,000, and District 4 reported a total of $163,227 for both Frances and Jeanne, which included both labor costs and equipment expenses. Some of the cost spreadsheets were provided by the Districts and are available in *Appendix B*.

Districts facing ITS equipment repairs generally relied on previously executed emergency contracts with maintenance contractors, who handled the work. District in-house staff members were also utilized for damage assessment and repairs. There were no contractual issues reported that the Districts could not resolve. The emergency contracts, rather than existing maintenance contracts, were the preferred means for providing the repairs because they facilitate the later reimbursement of repair expenses by the Federal Emergency Management Agency (FEMA) and the Federal Highway Administration (FHWA).

Generally, the Districts do not anticipate changes in their maintenance agreements or insurance requirements due to the damages sustained from the hurricanes and the resulting repair costs, although District 4 is still reviewing this issue, and District 6 indicated that they would see what feedback comes from the other Districts and react accordingly. Florida's Turnpike Enterprise also noted that their contractor is required to deploy and maintain eight generators as part of their ITS maintenance contract for the specific purpose of providing DMS operations within affected areas. Future maintenance contracts may include additional generator requirements, such as more units to provide power to CCTV or detection units at key locations on the Turnpike system.

3.9 511 Operations

The 511 Operations section outlines how 511 was used during the four hurricanes to assist with the evacuation and reentry process; what information was provided in support of this; and the call volume prior to, during, and after each hurricane. There are three areas of Florida where 511 is actively used – southeast Florida, central Florida, and the Tampa Bay area. The 511 services in the Tampa Bay area, however, were not available until September 1, so the call counts only reflect activity related to hurricanes Frances, Ivan, and Jeanne.

Table 3.3 – Southeast Florida Call Count

Period	Calls per Week*	Calls per Day
Week prior to Charley	45,332	6,476**
Day prior to Charley		8,135
Day after Charley		4,565
Week after Charley	40,712	5,816**
Week prior to Frances	45,318	6,474**
Day prior to Frances		5,816
Day after Frances		5,651
Week after Frances	41,727	5,961**
Week prior to Ivan	39,151	5,593**
Day prior to Ivan		6,773
Day after Ivan		7,040
Week after Ivan	45,969	6,567**
Week prior to Jeanne	46,823	6,689**
Day prior to Jeanne		7,889
Day after Jeanne		4,067
Week after Jeanne	50,552	7,222**

* Weekly call totals are approximate numbers based on the daily average call volumes.

** The totals are based on the daily average for the week noted.

Table 3.4 – Orlando Call Count

Period	Calls per Week*	Calls per Day
Week prior to Charley	29,246	4,178**
Day prior to Charley		4,937
Day after Charley		4,917
Week after Charley	26,390	3,770**
Week prior to Frances	35,763	5,109**
Day prior to Frances		1,319
Day after Frances		5,738
Week after Frances	25,823	3,689**
Week prior to Ivan	23,149	3,307**
Day prior to Ivan		3,564
Day after Ivan		3,394
Week after Ivan	20,041	2,863**
Week prior to Jeanne	23,807	3,401**
Day prior to Jeanne		7,156
Day after Jeanne		3,086
Week after Jeanne	29,736	4,248**

* Weekly call totals are approximate numbers based on the daily average call volumes.

** The totals are based on the daily average for the week noted.

Table 3.5 – Tampa Bay Call Count

Period	Calls per Week*	Calls per Day
Week prior to Frances	24,126	6,032**
Day prior to Frances		3,829
Day after Frances		15,616
Week after Frances	33,221	4,746**
Week prior to Ivan	11,327	1,618**
Day prior to Ivan		1,074
Day after Ivan		1,284
Week after Ivan	5,522	789**
Week prior to Jeanne	5,128	733**
Day prior to Jeanne		890
Day after Jeanne		3,219
Week after Jeanne	9,950	1,421**

* Weekly call totals are approximate numbers based on the daily average call volumes.

** The totals are based on the daily average for the week noted.

The southeast Florida 511 service provider is SmartRoutes Systems and they are responsible for obtaining the information that is disseminated on the 511 system. This information normally includes congestion, road closure, and construction information for the state highway system and limited-access facilities, but does not include travel times, delays, and speeds. During the hurricanes, SmartRoutes did not provide evacuation information directly through the 511 system. Instead, the service set up a separate telephone number for motorists to call to get this type of information. SmartRoutes only provided their normal information during the hurricanes, so if there was a problem with a reentry route – such as closed lanes or restrictions – it was reported through the normal reporting process as soon as the information was available. But if there was a problem with longer travel times, the information was not available.

The current southeast Florida 511 system does not allow call transfers to agencies outside the SmartRoutes' system. As a result, SmartRoutes did not provide call transfers to other agencies involved in emergency operations, such as evacuations. Advertisement of the 511 service using local DMS did not occur during the evacuation and reentry periods, but the 511 system itself was used to advertise other emergency services by providing telephone numbers for them. At no time during any of the hurricane events was the 511 system down.

The Orlando area's 511 system normally provides information on congestion, road closures, and construction information, along with travel times and delays on I-95 and Interstate 4 (I-4). In response to the hurricanes, the 511 system provided hurricane-related information as a header message under their special alert system feature and additional information on the status of tolls in the area. Information regarding shelter locations and space availability was provided by directing callers to a separate evacuee telephone hotline number for the Orlando-Orange County Convention and Visitors Bureau that was mentioned as part of the header message.

The Orlando 511 system cannot provide call transfers to agencies outside the system as it is currently configured.[8] As a result, the 511 service provider did not provide call transfers to other agencies involved in emergency operations, such as evacuations. Advertisement of the 511 service using local DMS did occur during the evacuation/reentry process, and 511 itself was used to advertise other emergency services by providing a separate telephone number for those services. At no time during any of the hurricane events was the 511 system down.

Tampa Bay's 511 system was not in service until the beginning of September and the service had 83,106 calls during that first month. Since the system is so new, the information from Tampa Bay may not be meaningful at this stage because the area's motorists are still discovering the system, and there are no call volume statistics to use for comparisons. Mobility Technologies®[9] is responsible for providing the information available on the Tampa Bay 511 system. This information normally includes congestion, construction, and road closure information on the state highway system and limited-access facilities, as well as travel times, delays, and speeds on I-4, Interstate 75 (I-75), and Interstate 275 (I-275) in the Tampa Bay area.

During the hurricanes, Mobility Technologies provided evacuation information through an alert process programmed into the 511 system. They had two levels of alerts: mandatory and voluntary. The mandatory alerts were provided as a floodgate message and the caller had no choice except to listen or hang up. With voluntary alert messages, it is up to the caller to access the voluntary alert message if they desire. Mobility Technologies also had people stationed in the county EOC and passed along the emergency alerts developed out of the EOC to the 511 system. In general, 511 was utilized as another means of disseminating information provided by the EOCs in the area, as well as relaying normal traffic information. The following information was provided on the 511 system in addition to normal services:

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[8] The I-4 511 system will be expanded with *i*Florida to provide both statewide and Central Florida 511 information for the Florida Intrastate Highway System (FIHS), as well as limited-access and arterial information in Central Florida. From the statewide level, the system will have the ability to transfer calls to the Tampa and Southeast Florida systems. This expanded system is expected to be fully functional on May 1, 2005.

[9] Mobility Technologies is a registered trademark of Mobility Technologies, Inc. © 2000 through 2004 by Mobility Technologies®. All rights reserved. Information is available online at http://www.mobilitytechnologies.com.

- Evacuation/Diversion route information was disseminated as pass-through information from county EOCs using mandatory or voluntary alerts.
- Information on the status of tolls was disseminated as pass-through information from the county EOCs using mandatory or voluntary alerts.
- Shelter information was disseminated using a telephone number and Web site address to access shelter information.

The Tampa Bay 511 system cannot provide call transfers to agencies outside the system as it is currently configured. As a result, Mobility Technologies did not provide call transfers to other agencies involved in emergency operations, such as evacuations. Advertisement of the 511 service using local DMS did not occur during the evacuation/reentry process, but 511 itself was used to advertise other emergency services by providing a separate telephone number or Web site address for those services. At no time during any of the hurricane events was the 511 system down. (The system was not available during Charley, having not yet been launched at that time.)

3.10 Web Site Operations

The objective of the Web site operations questionnaire was to measure the increase in usage as a result of the hurricanes, and to determine how the sites were utilized to assist in the dissemination of travel information pertaining to hurricane evacuation and reentry. This portion of the study also explored the issue of Web site reliability, particularly cases where the online service may have been interrupted by the hurricanes.

Southeast Florida was the only advanced traveler information system (ATIS) that had a functioning Web site to disseminate traveler information during the month of August when Charley hit Florida. Tampa Bay's Web site came online in the production mode beginning September 2 and was therefore not available during the first hurricane. Orlando does not have a functioning Web site at this time; however, District 5 will commission a Web site when they feature the *i*Florida Conditions System as part of the project's grant package.[10]

Table 3.6 notes the use of the southeast Florida Web site. The service provider, SmartRoutes, did not total the user sessions by day; they reported them by week and month. The averages noted in the table are based on the 2004 totals from SmartRoutes. Data on the Tampa Bay site was furnished by Mobility Technologies.

[10] More information regarding the FDOT's *i*Florida Surface Transportation Security and Reliability Information Systems Model Deployment Project is available online at http://www.iflorida.net.

Table 3.6 – Southeast Florida Web Site Use

Period	User Sessions per Day	User Sessions per Week	User Sessions per Month
Average prior to September 2004	-	56,596	246,596
Average including September 2004	10,478	73,345	318,991
September 2004	-	209,568	898,150
Week prior to Charley		86,132 [a]	
Week after Charley		62,531 [b]	
Week prior to Frances		492,543 [a]	
Week after Frances		119,882	
Week prior to Ivan		93,662 [a]	
Week after Ivan		85,462 [b]	
Week prior to Jeanne		92,150 [a]	
Week after Jeanne		57,277 [b]	

[a] This is an approximate number based on the average daily user sessions from the full week prior to the identified hurricane's arrival and the week that includes the arrival of the identified hurricane.

[b] This is an approximate number based on the average daily user sessions from the full week following the identified hurricane's arrival and the week that includes the arrival of the identified hurricane.

Table 3.7 – Tampa Bay Area Web Site Use

Period	User Sessions per Day	User Sessions per Week	User Sessions per Month
Average prior to September 2004	-	-	-
Average including September 2004	1,195	8,963	35,852
September 2004	1,195	8,963	35,852
Week prior to Frances	2,793	11,170 [a]	
Week after Frances	1,632	11,422	
Week prior to Ivan	917	6,422 [a]	
Week after Ivan	564	3,947 [b]	
Week prior to Jeanne	565	3,955 [a]	
Week after Jeanne	702	4,917 [b]	

[a] The totals are based on the daily user sessions from the seven days immediately prior to the identified hurricane's arrival. The figure for the week prior to Frances is a four-day total (i.e., September 1-4).

[b] The totals are based on the daily user sessions from the seven days immediately following the identified hurricane's arrival.

The Web sites, while disseminating information to the motoring public, do not provide exactly the same information. The southeast Florida Web site only provided information on congestion on all limited-access facilities, and most U.S. and state highways during the hurricanes – the same information they provide on a normal basis. As noted previously, Orlando does not have a Web site. The Tampa Bay Web site provided information on evacuation/diversion routes in the form of alerts as specific evacuation orders, and bridge or road closures were issued. Florida's Turnpike Enterprise provided information on toll status and shelters, but not on specific shelter location or capacity, and the FTE directed people to service plazas for specific shelter information. Other alerts included congestion information on all limited-access facilities, and most U.S. and state highways; travel times, speeds, and delays on I-4, I-75, and I-275 in the Tampa Bay area; and uniform resource locator (URL) links to public safety sites. None of the Web sites experienced any disrupted services during the hurricanes.

3.10.1 General Web Site Notes

For southeast Florida, Web site hits actually declined by approximately 75,000 user sessions from the previous month of July. July's totals were bolstered due to wildfires in Miami-Dade County. However, comparisons against the average for the year through August indicate a slight increase in user sessions over the average. It would appear that there was a slight increase in Web activity due to Hurricane Charley. However, since Charley did not actually threaten southeast Florida, the user sessions showed only a moderate increase at best.

Looking at September, when southeast Florida was directly threatened and impacted by two hurricanes, the user sessions shot up to about four times the average of the preceding eight months. The user session totals for the week including the arrival of Hurricane Frances shot up to an incredible 564,802 user sessions. However, user sessions dropped off significantly prior to the arrival of Jeanne, the other hurricane that directly threatened and impacted southeast Florida. This could be because users retained the information they received prior to the arrival of Hurricane Frances and did not feel the need to access the Web site again; were just tired of the hurricanes and decided to stay put and therefore did not need the information; or the information was not adequate and therefore they opted not to check the site again.

3.11 Dissemination Media

The dissemination of information on traffic and roadway conditions is of particular importance during times of natural disaster. Both prior to and following hurricane events, the public must be able to receive accurate and timely information so that they may evacuate from and return to affected areas safely and quickly. The following section discusses the various means available to the Districts and how they were utilized.

The main means of providing travel-related information to the public is through the media. In general, this information is given to the media by the District PIO and includes information from Traffic Operations staff on current road conditions, road closures, detours, debris removal, and signal repairs. Other means of disseminating information include text messaging, 511, and press releases. The DMS and HAR systems were also used to provide information on toll status, road closures, and detours, when appropriate. In District 1, for example, District operations centers and local government agencies relied on portable DMS units to provide motorist information and alerts regarding lane or road closures, particularly in locations with prolonged power outages.

3.11.1 Information on Other Dissemination Methods

3.11.1.1 Traveler Information Radio Network™

The Traveler Information Radio Network™ (TiRN™) is a public-private partnership that provides tourist information in central Florida. It covers the four counties of Brevard, Orange, Osceola, and Seminole. Information is broadcast from two stations, WTIR and WQBQ, which are amplitude modulated (AM) stations. The FDOT is given a total of six minutes each hour to provide traffic information on a regular basis, but during emergency events, the FDOT can utilize more time as necessary. Generally, the transportation information broadcast by TiRN is provided by both TiRN personnel and District 5's PIO, which utilizes cameras, information from the FHP, and information from their incident hotline.

During the days leading up to a hurricane that is expected to make landfall, TiRN broadcasts news provided by the Cable News Network (CNN) and reports information from county emergency operations personnel. TiRN, however, does not receive evacuation information from the SEOC. The SEOC has not had an opportunity to utilize the system until this year. The fact that TiRN is limited to the Orlando area reduces its potential as a major dissemination medium for emergency traveler information in Florida.

While the state did not provide information directly to TiRN from the SEOC, TiRN was still able to disseminate information about the hurricanes by tapping into a local TV news station. About one-and-a-half days before a hurricane's landfall is anticipated, TiRN begins broadcasting a feed from Orlando's Central Florida News Channel 13. TiRN generally does not interrupt Channel 13's broadcast to make special announcements. Special announcements are submitted to Channel 13 and work their way into the TiRN broadcast through the TV programming received.

The areas that TiRN broadcasts from were hit by three of the four hurricanes, causing major network impacts. Like most radio stations, TiRN's reliability depends on the availability of commercial power. One of their stations in Brevard County lost power and, as of Friday, October 1, 2004, was still without power; however, the other station never lost power. This was the extent of the impact to the network.;No equipment problems were experienced.

3.11.1.2 Everglades Radio Network

The Everglades Radio Network (ERN) is an educational service that provides information on the history of the Everglades; its wildlife and vegetation; and the Everglades' ecosystem restoration effort. The ERN consists of two low-power frequency-modulated (FM) radio stations that were constructed by the FDOT, are managed by the Florida Department of Environmental Protection (FDEP), and are operated by the Florida Gulf Coast University in Fort Myers. The planned broadcast radius was approximately 5 miles, although the actual broadcast radius reaches about 10 miles. The stations are positioned so that their broadcast area covers all of Alligator Alley on I-75 in Collier County, allowing motorists to tune in WFLP-FM at 98.7 megahertz (MHz) and WFLU-FM at 107.9 MHz to listen to the broadcast. Since the ERN is a licensed facility, each station must be tied into the Emergency Alert System (EAS) and is required to provide emergency information generated by the EAS.

The system is also set up so that the FDOT can interrupt broadcasts to provide traveler advisories and emergency information, such as hurricane evacuation guidance to motorists, when necessary. The process to get information aired on the stations requires the requestor to contact the Florida Gulf Coast University and, typically, the requestor provides a recorded message for the University to play on the air. However, because none of the hurricanes affected the Alligator Alley area, the FDOT did not utilize this resource.

3.12 The Microwave System and Communications through Cellular Telephones and Radios

In general, state-owned communication systems held up very well during the storms. The microwave system suffered some outages due to antenna damage on towers, but very little damage occurred on the towers themselves. Loss of power and unavailability of backup generators also caused outages at some locations. These resulted in some motorist aid call box locations being out of service for a time. Power outages at microwave towers were addressed using temporary generators until power could be restored. Maintenance technicians in affected areas utilizing Nextel radios reported no service for up to 24 hours and limited service for several days after each event.

The FDOT private radio system (47 MHz) performed very well with no outages reported during the storms. The public cellular systems encountered significant problems during the hurricanes. For several days after the storms, there were intermittent problems. The following sections indicate the extent of problems encountered from each storm.

3.12.1 Microwave System

Hurricane Charley's landfall in Charlotte County resulted in a localized failure of the FDOT microwave system. The Port Charlotte microwave tower site sustained approximately 140-mph storm winds that damaged three microwave antennas. As a result, the microwave network connectivity and motorist aid call box traffic was severed from Jacaranda to all points south. The microwave maintenance contractor, TransCore/Jack B. Harper, restored network service using the Port Charlotte diversity standby antennas until the main antenna repairs were completed. The system was completely out of service for about 24 hours during and immediately after the hurricane. Once the tower was accessible, limited service was quickly restored.

Additional antenna misalignments and commercial power failures occurred at other FDOT microwave tower sites as Charley moved inland and toward the east. Charley caused antenna system damage or misalignments at a total of eight FDOT microwave tower sites. Nine of the FDOT sites lost commercial power feeds. Power was automatically restored at four of the sites by permanently installed standby power generators. The FDOT supplied portable generators for three sites; however, FDOT generators were not available for two remaining sites that were without commercial power. Ultimately, the microwave maintenance contractor, TransCore/Jack B. Harper, provided personally owned generators and fuel supplies that restored power to the two remaining sites. Lightning and electrical surges caused tower lighting system damage at three of the sites and air-conditioning system damage at one site.

Hurricane Frances caused widespread power failures and antenna system damage at FDOT microwave communication tower sites as it tracked from Fort Pierce on the Atlantic Coast in District 4 to the Gulf Coast in District 3. A total of 18 FDOT microwave communication towers sustained antenna system damage or misalignments. Thirteen FDOT sites lost commercial power. Power was automatically restored at four of those sites by permanently installed standby power generators.

Four microwave communication tower sites were off the air and out of service for up to 48 hours due to FDOT delays in deploying portable generators to those locations. The FDOT ultimately supplied portable generators for three of the sites; however, an FDOT generator was not available for the fourth site. The microwave maintenance contractor, TransCore/Jack B. Harper, provided a personally owned generator and fuel supply that restored power to the remaining site. Lightning and electrical surges caused microwave communication tower site lighting system damage at five sites and air-conditioning system damage at two sites.

Hurricane Ivan caused widespread power failures at microwave tower sites located in District 3. None of the sites sustained antenna damage or misalignments. The Pensacola FHP standby generator failed to start when commercial power was interrupted at the site. The Pensacola FDOT microwave tower site and local motorist aid call box traffic were out of service for approximately 12 hours until FHP restored the standby generator service. Neither the FDOT nor TransCore/Jack B. Harper technicians were able to access the site due to bridge outages on I-10 and U.S. 90. Ivan caused loss of commercial power feeds to seven FDOT communication tower sites located along I-10. Power was automatically restored at all of the sites by permanently installed standby power generators.

Hurricane Jeanne made landfall near Fort Pierce, causing extensive statewide microwave tower site power failures and antenna system damage as it tracked across to the Gulf Coast. The Turnpike Site X microwave tower site was off-air and out of service for 48 hours after sustaining extensive antenna damage. As a result, the microwave network connectivity was severed at Site X and motorist aid call box traffic was out of service from Wildwood to Fort Pierce. The microwave maintenance contractor, TransCore/Jack B. Harper, restored network service using the Site X diversity standby antennas until the main antenna repairs were completed.

Jeanne caused antenna system damage or misalignments at 17 FDOT communication towers. Seventeen FDOT communication tower sites lost commercial power feeds. Power was automatically restored at seven of them by permanently installed standby power generators. Eight FDOT communication tower sites were off-air and out of service due to FDOT delays in deploying portable generators. The FDOT ultimately supplied portable generators for eight of the sites; however, FDOT generators were not available for the two remaining sites that were without commercial power. The microwave maintenance contractor, TransCore/Jack B. Harper, provided personally owned generators and fuel to restore power to the two remaining sites. Lightning and electrical surges caused tower lighting system damage at three sites and air-conditioning system damage at three sites.

Jeanne caused severe flooding at the Stuart, Ormond Beach, and Falmouth communication tower sites, which hampered technicians' access to communication shelters. The deployment of the FDOT portable generator to the Falmouth site was delayed after becoming stuck in the mud at that site.

After Charley, Frances, Ivan, and Jeanne, the microwave maintenance technicians' Nextel radios were generally out of service for a 24-hour period in areas in the immediate path of the storms' eyes. For several days thereafter, the Nextel network grade of service was generally intermittent as a result of Nextel-imposed restricted service.

3.12.2 Public and Private (47 Megahertz) Radio Systems

The 47 MHz system was up and operating in District 1 during Hurricane Charley. Two locations where 47 MHz operation had been replaced by use of Nextel handsets were found to have failed. Whether the radios had failed prior to Charley's path through District 1 is not known because use of the radios was not attempted until after Charley struck. The location and nature of failures were not discussed in detail, but they were described as "minor." At the Arcadia location, the problem was the remote desk unit and not the base station.

Nextel was described as being unusable for the first 48 hours after Charley, and spotty in coverage and availability for the next week. Verizon®[11] was operational virtually throughout the first 48 hours, and ALLTEL®[12] telephones also performed well.

District 1 reported that it fielded its satellite telephones during the disasters, using them mostly in push-to-talk (PTT) mode because that service is charged a lower rate than full duplex telephone service. District 2 reported that the 47 MHz system was fully operational throughout Charley and communications were not noticeably affected. Nextel's normal operation was described as spotty in locations near I-75 in Columbia County and virtually nonexistent in Taylor County.

District 5 reported no problems with the operation of its 47 MHz radio system during Hurricane Charley, though the private radio system, operated base-to-base, was the only communication method between District 5 headquarters and Oviedo Maintenance. They also noted that Nextel handsets did not work in either PTT or telephone mode for at least 48 hours. An AT&T cellular handset gave repeated "system busy" fast beeps during the same period.

Turnpike maintenance communications were out of service for 12 to 18 hours at the north end of the system only, primarily due to a commercial power loss at the Orlando South microwave tower site. Due to this loss of power, the Lake Worth Plaza was unable to communicate with any maintenance repeater north of that location. Nextel was "useless" in the affected areas for a week following the hurricane. The Turnpike uses only Nextel services.

The remaining Districts reported no radio communication problems due to Charley.

The 47 MHz system in District 1 was operational throughout Frances. Nextel and the public cellular systems had downtimes immediately after the storm, but were mostly operational within 24 hours. Although Frances caused significant damage to property in District 2, the 47 MHz system had no failures. However, Nextel's coverage was nonexistent the first day, and worse than normal during the remainder of the week after the storm. Commercial power was out in many areas for as much as a week.

[11] Verizon is a registered trademark of Verizon Communications, Inc.

[12] ALLTEL is a registered trademark of ALLTEL.

District 4 suffered extensive damage from Hurricane Frances. The 47 MHz system sustained damage in the West Palm Beach, Stuart, and Fort Pierce maintenance offices. All the damages to the stations were minor, but disabling. West Palm Beach suffered a telephone line failure that prevented transmitter keying and monitoring from the maintenance facility. This failure was repaired within 30 minutes by the District 4 technicians upon their arrival. The Stuart maintenance transmitter suffered module failure, most likely caused by a lightning strike. This repair took less than 15 minutes because the technicians had brought a spare transmitter of the same make and model, and the defective module was simply replaced with the functioning one. Fort Pierce incurred a blown fuse, either as a result of a surge on the power input or some other unknown event. The fuse was replaced and the unit functioned. All equipment was repaired early in the day after the main part of the storm had passed. The condition of Nextel and the cellular systems was not reported, but can be assumed to have been essentially out of operation during the first 24 hours.

District 5 reported that they had no problems with the 47 MHz radio system and it was the primary communication system used during damage assessments. Nextel and cellular systems were generally not reliable or available during the first 48 hours.

The Turnpike's maintenance communications were out of service for 36 hours following Frances. Fort Pierce local operations were also inoperative due to failure of both commercial power and generator wiring to the communication equipment. The more significant problems were the failure of the Site X – Kenansville link, and the communication link between West Palm Beach and the Lake Worth Plaza, which disabled all centralized communications for the 36 hours. Some of the microwave tower sites were not repaired for four days, so full service was not restored for that period. Again, Nextel service was not available in the affected areas until after the FDOT's private services were restored. The remaining Districts reported no problems with radio communications due to Frances.

Aside from rain and some site flooding, Hurricane Ivan had little effect on private and public communications within District 2. Ivan caused extensive damage in District 3, primarily in the portion of the District that lies west of Fort Walton Beach. The 47 MHz system continued to work, and was the only link to FDOT personnel in the Pensacola and Milton areas, where damage was worst.

Nextel stations were not operable in the Pensacola and Milton areas, and were basically out of service for a couple of weeks, although this depended on the user's particular location. All damage reporting was conducted using 47 MHz radio communication. On some newer vehicles, the radios were installed, but antennas were left off for cosmetic reasons. Several of those vehicles have now been retrofitted with antennas to make the radios operable. The remaining Districts reported no problems with radio communications due to Ivan.

The 47 MHz system remained operational throughout Jeanne. Nextel and the public cellular systems had early outages, but were mostly operational on a limited basis within 24 hours. The Turnpike's maintenance communications were out of service for 36 hours for mostly the same reasons as Frances. However, the microwave service contractor prearranged for tower crews, so service was restored more quickly on the Site X microwave tower. Fort Pierce also failed again, but was restored within 24 hours. As before, Nextel service was either not available or unsatisfactory for about a week following the storm.

4. Florida Department of Transportation Trends in Hurricane Response

While researching the actions the FDOT took before, during, and after the four hurricanes, a number of activities emerged that were common to most, if not all, of the Districts:

- Portable message signs were consistently used to mark detour routes and to provide motorist information.
- Districts deployed crews to other Districts to assist in cleanup and, in some cases, to prepare for the upcoming storm.
- Tolls were suspended in every storm to assist in the evacuation and reentry processes.
- Detour routes for commercial and through-traffic were established for any major routes that were damaged. At times, this entailed cooperation with other state departments of transportation.
- Emergency contracts were implemented in all Districts to help with cleanup and emergency repairs.
- Tolls were lifted for individuals traveling to Florida to assist in relief efforts after each hurricane.
- Motorist assistance telephone hotlines were established on an as-needed basis, though it was unclear how information for these lines was disseminated or who staffed the lines.
- Generators were deployed at major intersections.
- The 511 system was used as a means of disseminating information to the public, but was not specifically advertised as a source of information during the hurricanes.

These trends reflect good practices established by the FDOT in each District to assist their roadway systems in hurricane preparations; to recover as quickly as possible; and to assist the traveling public in safely evacuating and returning to their communities.

5. Recommendations

Recommendations were made during the interview process that touch on almost all of the areas reviewed. These recommendations are divided into 13 of the 14 categories in which information was gathered and are outlined below. (Respondents' answers to the General Information questions were not included in this report. The Signal Equipment, and the Mast Arm and Span Wire questionnaires were combined.)

As a general recommendation, the FDOT TEOO should develop a plan that addresses the recommendations in the following areas. Each District should develop its own individual plan that ties into the TEOO plan, and that specifically addresses the unique situations and needs of that District as they relate to the areas covered in this section.

5.1 Signal Operations

The signal operations section was limited to very specific topics and the recommendations that the FDOT may desire to follow up on include:

- Improve internal time clocks for traffic signal controllers.
- Develop timing plans for evacuations as feasible.
- Retime signals as appropriate after an emergency in such locations as detour routes and heavily traveled areas.
- Organize assessment and repair teams in advance.
- Develop and maintain a stock of replacement parts and equipment.
- Develop emergency response contracts and have them ready to go prior to an emergency;
- Install generators to get power back online as soon as possible.
- Institute stop control as appropriate at major intersections if generator power is not feasible.
- Explore the issues raised with signal head removal.

5.2 Expectations for Signal Restoration

The recommendations for signal restoration operations are:

- Establish emergency contracts in advance for quicker restoration.
- Create agreements with other state governors' offices to waive liquidated damages for contactors assisting in emergency response situations, if feasible.
- Make available a standing stockpile of spare parts, such as hangers, signal heads, generators, and related hardware for distribution to maintaining agencies.
- Consider training traffic operations and other District staff in signal damage assessment and the documentation procedures required by the FHWA.

5.3 Mast Arm, Span Wire, and Signal Equipment Issues

The FDOT has determined that a new design is warranted for hangers used in signal head installations at intersections. As the evidence from storm damage illustrates, the hangers are placed under considerable stress due to the span wire configuration when winds begin swinging the signal heads. A new prototype hanger is being designed by the FDOT's TEOO, Design, and State Structures offices. The Structures Office will test the prototype to ensure compliance with stress requirements. Once the new design has been tested, the FDOT will produce a standard design for the hanger device based on the prototype, and seek the award of a patent for the device.

5.4 Power Outages and Generator Use at Signalized Intersections

With regard to generators and their use, the following recommendations are made:

- Establish generator backup for all major signalized intersections. Major intersections should be identified by the DTOE in whose jurisdiction the intersection belongs. This could be either a permanently mounted generator or one stored at a nearby facility. If the latter option is chosen, a plan for ease of deployment and a means of prioritizing the intersections for deployment needs to be established.

- Evaluate each of these intersections to see whether a power panel is readily accessible. If it is, the generator should be connected at this location. If not, then the intersection needs to have a cabinet that is prewired to accept backup power from a generator placed there. It should be noted that this change in cabinet design will require a change to the *Design Standards*[13] and should be labeled as optional, since not all designs will require this type of cabinet.

- Evaluate the intersections requiring backup power to determine the best, most secure placement of the emergency generators to provide easy access for connection and maintenance, and to prevent theft.

- Consider requiring maintenance contractors to maintain a minimum number of generators to power critical ITS field devices as determined by the appropriate District.

- Establish District plans for the refueling of generators and their maintenance during the aftermath of a hurricane or other occurrence that necessitates their placement. These plans should include options if fuel is not commercially available in the area due to an incident or the limited manpower most agencies operate with to do this work.

- Require light-emitting diode (LED) signal heads for all intersections on the state highway system to minimize power requirements.

5.5 Maintaining Traffic on Evacuation, Reentry, and Diversion Routes

Local-level planning and coordination is essential in setting up evacuation and diversion routes, and ensuring attention to important details. The recommendations for evacuation/diversion routes and MOT operations include:

- Include standard generator hookups in traffic signal controller cabinets to expedite emergency backup power placement and thereby eliminate the need for an electrician.

- Provide a large inventory of generators in critical areas and make available a surplus of traffic signals.

- Pursue greater ITS deployment not only along the interstates, but also along major arterials.

[13] Florida Department of Transportation, *2004 Design Standards* (July 2003). Available online at http://www.dot.state.fl.us/rddesign/rd/RTDS/2004_Standards.htm.

- Use Road Rangers and FDOT resources to patrol the roadways. Road service units on these routes should be increased for everyday service prior to hurricanes and during actual emergency evacuations.

5.6 Road Rangers

Several topics covered under the Road Ranger section produced the following recommendations:

- Have financial support in place during emergency evacuations so that contractors know that they are able to do what needs to be done.
- Give ample notice to contractors and their staffs regarding the need for extended hours.
- Train in-house personnel as additional Road Ranger staff in case of emergencies, if a cost-effective training method can be found.
- Develop a redundant means of communication for Road Rangers for use when cellular services, such as Nextel, are not available.

5.7 Transportation Management Center Operations

Transportation management center operations are one of the most critical areas in the effort to effectively disseminate accurate information about the state highway system and limited-access facilities during an emergency event. When a TMC is in operation, it can act as a clearinghouse for information regarding the facilities in the District. The following are recommendations that the FDOT may need to put in place for TMC operations before, during, and after the next hurricane or similar emergency event:

- Develop a plan for emergencies, such as hurricanes, and update it annually. The plan should include, at a minimum, a list of all staff and their contact information; the roles and responsibilities of the staff; the expected staffing criteria and schedules, if applicable; the criteria for shutting down and starting up the TMC in an emergency, including an indication of remote operations capability; what provisions will be supplied to the staff, how to obtain the provisions and what the staff will be responsible for supplying; a maintenance plan for all the equipment, including information on what to do year round, immediately prior to, during, and immediately after an event; a test plan for all backup equipment, such as generators; a backup communication plan for communicating with staff and partners if power or cellular services are down; and how to conduct damage assessments after the storm.

- Develop redundant communication systems, if feasible, for controlling TMC and field devices, such as wireless and Voice Over Internet Protocol (VOIP) services.
- Develop redundant power supplies for field devices and generators used to power critical field devices as defined by the TMC manager and the DTOE.
- Ensure the availability of a complete stock of spare parts for field devices.
- Use DMS and HAR to provide evacuation, shelter, and curfew information.
- Place staff at county EOCs, as feasible, to obtain real-time emergency information and relay it back to the TMC, or have remote operations capabilities at the county EOC.
- Develop statewide guidelines for the use of DMS during hurricanes and similar emergencies.
- Develop a communications plan between the FDOT Central Office TEOO and TMCs for use during emergencies, with the objective of communicating with TMCs located throughout Florida.

5.8 Intelligent Transportation System Field Devices

Most of the damage done to Florida's ITS field devices was due to wind and water exposure, with sustained service outages attributed to communication or power losses. The following are areas that the FDOT may consider for future emergency planning with regard to ITS field devices:

- Develop and maintain a spare parts inventory that includes replacements for such devices as CCTV cameras, where feasible.
- Consider requiring maintenance contractors to maintain a minimum number of generators to power critical ITS field devices as determined by the appropriate District.
- Develop redundant communication systems to the extent that they are cost effective.
- Develop emergency contracts and have them ready for immediate implementation in cases of emergencies.
- Train in-house staff, as feasible, to troubleshoot and make repairs to ITS field devices.

5.9 511 Operations

The FDOT has three 511 systems up and running at this time. All of them provide road closure, congestion, and some construction information, while two also provide more detailed information on travel times, speeds, and delays as available in their locales. Under this area, the following recommendations should be reviewed:

- Standardize the information provided by the systems.
- Implement call transferring to agencies outside the system.
- Advertise the system as an information resource for evacuation, diversion, and reentry route information for the state highway system and limited-access facilities.

5.10 Web Site

The FDOT currently has two Web sites that provide traveler information to the public – the southeast Florida Web site, put into place several years ago, and the Tampa Bay Web site, which was recently activated. The information provided on these Web sites relies heavily on information being provided by others and the extent of the ITS that is supporting this service. As can be seen from the Web site section, the information provided on the Tampa Bay site was more robust, which can be attributed to its recent deployment and the information being provided by Mobility Technologies on travel times, delays, and speeds. While the information provided is helpful to the public, the FDOT should investigate the following:

- Update the southeast Florida Web site to provide travel times, speeds, and delays, as well as some of the other information provided by the Tampa Bay Web site.
- Continue to deploy ITS throughout the state to support the data gathering necessary for such Web sites, and to encourage other areas to either develop their own Web sites or develop one centralized site that can be furnished with information from around the state.

5.11 Dissemination Media

The FDOT has two broadcast networks currently available, TiRN and the ERN, which can be used not only during normal circumstances but also during emergency situations. The FDOT should work in conjunction with the networks to develop an emergency plan that will allow the FDOT to provide information about state highway system conditions directly to motorists, specifically with regard to what is being done to facilitate hurricane evacuation and reentry operations.

5.12 Microwave System and Communications through Cellular Telephones and Radios

The recommendations for the microwave system, and communications through cellular telephones and radios are:

- In general, the state-owned communication infrastructure performed well during the hurricanes. There were some significant local outages due to wind damage and power outages at the tower sites. Though the maintenance contractor performed well in system restoration operations, the FDOT's plan to install fixed standby power generators at microwave tower sites is a critical element in maintaining system communications.

- Site flooding and inaccessibility prevented timely response at several communication sites. Attention to drainage improvements will reduce recovery time that was prolonged due to flooding at these sites.

- The widespread failures of the Nextel system and other commercial communication providers indicate that cellular and enhanced specialized mobile relay (ESMR) or other commercial wireless service providers (e.g., Nextel, ALLTEL, Verizon, Cingular, etc.) should not be relied on to provide mission-critical communications. Either they become overloaded due to general public use during such emergencies or they fail due to the local tower's inability to access the remote system controller. However, public systems provide additional flexibility compared to private radio systems. These public radio systems should continue to be used where it is advantageous to do so, but should not be the only options available to District or FTE personnel. The FDOT does not control access to them, so availability during emergencies cannot be expected.

- Districts and the FTE should continue to use and maintain the FDOT radio system so they are assured of communications during emergencies.

- The FDOT radio base stations are being upgraded for all Districts to improve the range of mobile-to-mobile communications and to provide additional flexibility for radio operators away from their mobile units.

- Contractors who provide services to the FDOT during emergencies should be included in the FDOT communications system. Federal Communications Commission (FCC) regulations permit public safety entities like the FDOT to allow contractors to use their radio systems for communications related to the sponsoring public safety agency's responsibilities. In this case, the contractors operate under the authority of the FDOT's license.

- The failure of the Turnpike radio system was related to loss of the microwave system's functions at Site X and West Palm Beach. The upgrades now being performed on the FDOT statewide microwave system provide route diversity and alternate power sources. These upgrades will overcome the loss of the control link between the Turnpike's dispatch centers and its multiple maintenance radio stations along the tollway.

6. Actions by the Florida Department of Transportation

As the research and preparation for this report came to a close in late 2004, discussions were already taking place concerning the FDOT's course of action in preparation for the next hurricane season. At the DTOE-FACERS-FSITE-ITSFL Meeting held on January 27, 2005, in Miami, Florida, the attendees agreed to pursue various items. These items are detailed in the following subsections.

6.1 Policy Statements

Based on further discussions by the FDOT and other attendees, decisions on policy matters related to traffic operations in response to hurricanes have been reached. The policy statements are summarized below.

- With the approval of the FDOT, signal heads may be removed if desired as long as there are the resources to accomplish the removal, and as long as the removal does not impact evacuation efforts or public safety. Removal of signal heads will not violate the FHWA's minimum requirements as detailed in the *Manual on Uniform Traffic Control Devices* (*MUTCD*).

- The DTOEs and the signal maintaining agencies will work together to create a policy on the placement of mast arm traffic signals at intersections in lieu of span wire signals. This policy will be based on the following criteria:

    - Evacuation routes
    - Strategic intermodal system (SIS) routes
    - A prioritized list agreed to by the DTOEs and the signal maintaining agencies

6.2 Consensus Item

A consensus was reached among the attendees that 72 hours is a reasonable downtime for signalized intersections after an emergency event.

6.3 Action Items

The following summarizes the action items agreed to at the meeting held on January 27, 2005:

- **Hurricane Plan –** The Central Office TEOO will develop a Hurricane Plan in response to the storm events of 2004 based on guidance provided at the January 27, 2005, DTOE meeting and the recommendations contained in this report. This plan must be coordinated with District-developed hurricane plans and consider District emergency response plans already in place.

- **Cabinet Redesign –** The traffic signal control cabinets at intersections need to be redesigned for generator connection. This will include a new design for new installations and a retrofit design for existing installations.

- **Light Emitting Diode Signal Heads –** The new policy will be to install only LED signal heads in future projects. The TEOO's work in this regard will be coordinated with the State Specifications Office to facilitate the necessary changes.

- **Generators –** The Districts will be contacted regarding the number of generators they are willing to store and maintain, and the TEOO will make the same decision for the Central Office.

- **Critical Signs –** Research is needed on what constitutes a critical sign, what design life these signs should be designed for, and when they would need to be back up after a hurricane. The TEOO and the Structures Office will work on this issue. The Structures Office is also considering two additional actions: (1) increasing the design recurrence interval for large interstate sign structures; and (2) revising the wind speed criteria for miscellaneous structures so that the criteria the FDOT uses is consistent with the requirements of the *Florida Building Code*.[14]

[14] International Code Council®, *Florida Building Code* (July 2004). More information is available online at http://www.floridabuilding.org/bc/default.asp. International Code Council is a registered trademark of the International Code Council, Inc. © 2005 International Code Council.

Appendix A

Hurricane Response Questionnaire and Replies

Hurricane Evaluation Questions

Signal Operations

1) Did you reduce the number of signal heads on intersections to try and minimize damage?
   a) If so, what actions did you take?
   b) If you considered this option and did not implement, please explain your reasons why.
   c) If you did not take this action, would you consider doing so in a future hurricane or emergency?
2) How many of the counties/maintaining agencies removed signal heads in advance of the hurricanes?
3) What recommendations would you make to improve signal operations before, during, and after a hurricane?
4) What recommendations would you make to bring the signal system back on-line after a hurricane?
5) Were you able to maintain signal coordination during and after the hurricanes?
   a) If so, was the interconnect system intact?
   b) If the interconnect system was not intact, how did you maintain coordination?
6) Did you operate the signals with less heads to reduce power consumption?

Expectations for Signal Restoration

1) Having just gone through this experience, what are the primary issues with restoring an intersection on a state road?
2) What would be considered reasonable for a county road?
3) Describe any priorities for restoration and what considerations go into the prioritization, such as traffic volumes, functional classification, critical links, emergency services, etc.?
4) What difficulties did you encounter in restoring signal systems that weren't expected? How did you manage those problems?
5) What recommendations would you make to improve the restoration process?

Mast Arm / Span Wire Issues

1) How many of your signals are mast arm mounted by maintaining agency?
2) How many signal heads, by maintaining agency, are horizontally mounted and how many are vertically mounted on mast arms?
3) How many signal heads did you lose by mast arm and strain pole mounting?
   a) How many of these losses were due to bracket failures?
   b) How many of these losses were due to span wire failure?
   c) How many of these losses were due to pole or mast arm failure?
4) Which brand of mounting worked the best during the hurricane(s)?
5) Do you have any recommendations on mast arm versus span wire mounting for hurricane conditions?
6) Do you have any recommendations on horizontally mounted mast arms versus vertically mounted mast arms?

Signal Equipment

1) How many signal maintaining agencies operate in your District?
2) How many signals and signal systems do you have per maintaining agency?
3) How many signals and signal systems damaged/destroyed by the hurricanes per maintaining agency?
4) How many of the inoperable signals and signal systems were not functioning due to power outages, flooding, or other physical damage per maintaining agency?
5) What are the implications (i.e., cost, safety issues, etc.) of raising the cabinet height in low-lying areas?
6) How were the school zone signs, specifically those mounted on span wire, impacted by the hurricanes?
7) What benefit, if any, is there to powering school zone equipment through solar power instead of regular electrical service?

Power Outages and Generator Use at Signalized Intersections

1) Did your District purchase generators to power intersections that were left without power after the departure of the hurricane(s)? If so, how many did your District purchase?
2) If your District purchased generators and/or received generators from other sources, such as the 552 purchased by Central Office:
   a) How were they deployed (i.e., just at critical intersections)?
   b) How long did they run before needing to be refueled?
   c) Did you experience any difficulties with the generators (i.e., generators failed, burned out, maintenance, stolen, etc.)?
3) Has your District purchased, in the past, any permanently installed generators to power select intersections?
4) Are your signal cabinets prewired to accept an alternate power source, such as a generator?
5) What are the unexpected costs, beyond fuel and equipment costs, associated with providing backup power at critical intersections?
6) What recommendations, if any, would you make to improve traffic system signal operations during another hurricane or similar emergency regarding power supply to the intersections?

Maintaining Traffic on Evacuation, Reentry and Diversion Routes

1) How and when where you alerted to prepare evacuation routes and possible one-way operations?
2) How well did your diversion routes for evacuation traffic function?
3) What went well with regard to the diversion routes?
4) What would you alter with regard to how the diversion routes function?
5) Was access management added to your arterial streets?
   a) If so, what did you do?
   b) How well did it work?
   c) What would you do differently?
6) How well did your diversion routes for re-entry traffic function?
7) What went well with regard to the re-entry routes?
8) What would you alter with regard to how the re-entry routes function?
9) How was detour/diversion route information made available to the public?
10) How should detour/diversion route information be made available to the public?
11) Overall, what items would you retain for future hurricanes (i.e., stockpile items)?
12) Were there any problems with opening through lanes that were closed due to construction?
13) What did you do to alleviate/mitigate flooding, if present, on the evacuation route?
14) Did you develop plans for flooding mitigation of evacuation routes after experiencing the first hurricane (i.e., after being hit with the first storm and knowing there were other storms possibly coming)?
15) Did your District develop and implement plans to maintain traffic flow on evacuation/diversion routes?
   a) What impediments to traffic flow were encountered?
   b) What counter-measures were implemented?
   c) What was successful in maintaining traffic flow on evacuation routes?
   d) What would improve the process of maintaining traffic flow on evacuation/diversion routes?

Road Ranger Operations Questions

1) What preparations did you make leading up to the hurricanes?
2) Describe any changes to staffing and work hours?
3) Was additional fuel purchased?
4) What maintenance was performed on the vehicles to ensure a full fleet?
5) Did you have internal meetings with the drivers to discuss potential situations/responses?
6) Describe the discussions with the District, Emergency Operations Center (EOC), Florida Highway Patrol (FHP), or other emergency services personnel concerning plans/procedures for the hurricanes? If so, what plans were developed and how did they perform?
7) Do you have any suggestions to improve preparation for the hurricanes?
8) Describe what actions were taken during the hurricanes.
    a) Were you called on to assist in any unusual incidents/circumstances?
9) Did you help facilitate traffic flow during the evacuation? If so, how?
10) Do you have any suggestions to improve on the actions taken during the hurricanes?
11) Describe your involvement in the recovery effort after the hurricanes.
12) Did you assist with clean-up after the hurricanes? If so, how?
13) Were you involved in maintenance of traffic (MOT) during re-entry?
    a) Were you called on to assist in any unusual incidents/circumstances during re-entry?
14) Do you have any suggestions to improve on the actions taken during recovery after the hurricanes?
15) At what point during the hurricanes were you told to stop services and take shelter?
    a) Do you think that you could have provided services after this point?
    b) Do you think that services should have been stopped sooner?
16) At what point were you told to resume services?
17) Do you think services could have been resumed earlier or later?
18) What service did you find you provided the most? (i.e., providing fuel, changing tire, providing directions, etc.)
19) Did you provide assistance to other Districts before, during, or after the hurricanes?
20) Could you have provided assistance to other Districts had it become necessary?

21) What issues did you encounter before, during, and after the hurricanes (i.e., fuel shortages, communication issues, route problems, a high volume of assists, a need for directions, etc.)?

22) What communication methods were used to contact the Districts/drivers/dispatch before, during, and after the hurricanes?

    a) How did each method work?

23) Did you lose communications? If so, for how long?

24) What was the backup communication media used?

25) How many additional hours did you work before, during, and after the hurricanes?

26) How many additional drivers did you utilize to cover the additional work?

27) How many additional stops (above average) occurred during the evacuation and return?

28) Did you encounter any contractual difficulties in accommodating the needs arising from the hurricanes?

29) What would you do differently should another hurricane be anticipated and why?

Transportation Management Center Operations

1) Do you have a hurricane plan? If yes, please describe.
   a) Was the plan effective during these hurricanes and, if so, how?
2) What preparations did you make for the hurricanes?
3) What role did you play before the hurricanes in evacuation/preparation?
4) What impact did the hurricanes have on your overall operations?
5) How did your communication systems (i.e., data, video, voice, and fax) work before, during, and after the hurricanes?
6) Were you operational throughout the hurricanes?
   a) If you were operational, did you operate the systems with your usual staffing levels and staff, or did you turn the system over to another agency partner?
   b) How did the system operate during the hurricanes?
   c) What difficulties did you encounter?
7) What provisions did you make for sheltering and providing the employees food and rest?
8) If you turned the system over to another partner, what level did they staff the system at and did they encounter any difficulties that you are aware of?
9) If you didn't stay operational during the hurricanes, at what point was the decision made to shut down operations?
10) How long after the hurricanes did operations resume?
11) Once you were up and operational again, what was your role in the re-entry/recovery efforts?
12) What recommendations do you have to improve how hurricanes are handled in the future with regard to operations?
13) If you had to go through a hurricane again, what would you do differently before, during, and after the hurricane?

Intelligent Transportation System Field Devices

1) What field devices [i.e., closed-circuit televisions (CCTVs), detectors, etc.] did your District have deployed and in operation prior to the hurricanes?
2) Did your field devices sustain damaged during the hurricanes? What devices were damaged? Was the damage isolated or widespread?
3) Were there any field devices damaged beyond repair?
4) What was the cause of the damage (i.e., water damage, wind damage, no power, communication failure, lightning or power surges, structural failure, etc.)?
5) If the devices are back on-line, how long did it take to repair and/or replace each type of damaged device?
6) If the devices are not currently on-line, what is impacting their return to normal operation?
7) How much did it cost to repair the damage? Please detail the infrastructure repair costs as well as the labor costs (if possible).
8) How did you facilitate the repairs, FDOT maintenance forces and/or contracted services? Were there any contractual issues you had to overcome?
9) Was the repair work covered in your maintenance agreements or did FDOT personnel do the work?
10) Are there any changes to your maintenance agreements or insurance requirements anticipated due to these repairs and/or costs?

511 Operations Questions

If there is a 511 service operating in your District, please answer the following questions:

1) What was the average call volume/duration in the week leading up to each of the hurricanes?
2) What was the average call volume/duration on the day prior to each of the hurricanes?
3) What was the average call volume/duration on the day after the hurricane?
   [*Note that the system may or may not have been available at that time. If not, please note that.*]
4) What was the average call volume/duration in the week(s) after the hurricanes?
5) How did you utilize 511 to assist in the hurricane evacuation and re-entry? Did you provide:
   a) Evacuation/Diversion route information?
   b) Contraflow operations information?
   c) Status of tolls (e.g., suspension)?
   d) Shelter information?
   e) Travel safety tips?
   f) Re-entry routes, rules, and restrictions?
   g) Congestion information and locations?
   h) Call transfers to other agencies/services involved in the evacuation/re-entry?
   i) Key route average travel times, speeds, delays? If so, which route?
   j) Other?
6) Did you "advertise" 511 on any dynamic message signs (DMSs), highway advisory radios (HAR), or other methods as a means for evacuees to obtain information?
7) Did you use 511 to "advertise" other methods of obtaining evacuation and operations related information?
8) How long was 511 available leading up to the hurricanes?
9) If 511 was out of service after the hurricane, how long did it take to restore 511?

Web Site Operations Questions

If there is a real-time traveler information Web site operating in your District, please answer the following questions:

1) What is the average number of user sessions per day/week/month?
2) What was the average number of user sessions in the week leading up to each of the hurricanes?
3) What was the total number of user sessions the:
   a) Day prior to each of the hurricanes?
   b) Day of each of the hurricanes?
   c) Day after each of the hurricanes?
   d) Week after each of the hurricanes?
4) How did you utilize the Web site to assist in hurricane evacuation and re-entry? Did you provide:
   a) Evacuation/Diversion route information?
   b) Contraflow operations information?
   c) Status of tolls (e.g., suspension)?
   d) Shelter information?
   e) Travel safety tips?
   f) Re-entry routes, rules, and restrictions?
   g) Congestion information and locations?
   h) Key route average travel times, speeds, delays? If so, which route?
   i) Universal resource locator (URL) links to other agencies/services involved in the evacuation/re-entry?
   j) Other?
5) Was Web site service disrupted during any of the hurricanes? If so, when, for what reason, and how long did it take to return to operation?

Dissemination Media

1) Did you provide travel-related information to the media during evacuation and re-entry? If so:
   a) What information was provided to the media?
   b) How was the information provided to the media?
   c) Did you work directly with the media or with the FDOT's Public Information Office (PIO)?
2) Did you provide information through the use of:
   a) Roadside information devices, such as dynamic message signs (DMS), highway advisory radios (HARs), or rest area displays?
   b) Did you use portable DMS?
3) If you used any of these, please describe what and how you used them.

Microwave System

FDOT Emergency Communications / Emergency Operations:

1) Was the FDOT Emergency Operations Center activated in affected Districts?
   a) If so, what communications were available at activation and during the operation?
2) Were there any communication system failures?
   a) If so, please identify which ones and where.
3) Who maintains the emergency communications operation?
   a) How often is it checked?

Nextel or Enhanced Specialized Mobile Radio (ESMR):

1) During each emergency, did the Nextel/ESMR services fail? If so, please identify locations, time and date of failure, and time and date of return to service.

Cellular Communications:

1) What cellular providers are used in your District?
2) During each emergency, did the cellular service fail?
   a) If so, please identify by provider, location, date and time of failure, and date and time of return to service.

FDOT Radio System (47 MHz System):

1) Was the FDOT 47 megahertz (MHz) system functional? If not, please provide locations of station(s) that were not functional; the date and time of failure; and date and time of return to service.

Motorist Aid Microwave System:

1) Were the motorist aid trailer-mounted portable generators needed, or did each microwave station operate satisfactorily?
2) Where does your District keep the motorist aid trailer-mounted portable generators?
3) Who controls the use of the motorist aid trailer-mounted portable generators?
4) Are the generators cycled periodically?

Overall:

1) What changes, modifications or new systems would you recommend for improved reliability in order to shorten response time and enhance safety during similar events?

Motorist Aid Microwave System Sites:

The Motorist Aid Microwave System Site Maintenance Contractor experienced severe problems attempting to access various sites due to flooding. This has been an on-going problem, less severe under normal conditions, for the past 24 months. Can the individual Districts upgrade access roads and address drainage issues to help retain 24-hour-a-day/7-days-per-week access for service to all the sites, especially the ones listed below?

District	Site Name	Location
1	Collier County	I-75 Rest Area, Mile 63
1	Estero	I-75, Exit 123
1	Jacaranda	I-75, Exit 193
1	Fruitville	I-75, Exit 210
2	Falmouth	I-10, Exit 275
2	Sanderson	I-10, Exit 324
2	SR 16	I-95, Exit 318
2	Yulee	I-95, Exit 373
4	Andytown	I-75 Tollbooth, Mile 25
4	Indrio Road	I-95, Exit 138
4	Fort Pierce	At the FDOT Maintenance Yard
4	Stuart Turnpike Plaza	Turnpike Service Plaza, Mile 143
5	Sanlando Springs	I-4, Lake Mary Rest Area, Mile 96
5	St. Catherine	I-75, Exit 309
5	Wildwood	I-75, Exit 329
5	SR 318	I-75, Exit 368
5	June Park	I-95, Exit 180
5	Ormond Beach	I-95, Exit 273
7	Jessimine	I-75, Exit 293

Center to Center Implications:

1) What is the feasibility of providing video images to the EOC/SEOC?

2) What actions would be required to allow it to be feasible?

Communications through Cellular Telephones and Radios

1) Was there an impact on your wireless communications due to the hurricanes?
2) What was the impact and how long (during or after) the storms did it continue?
3) Do you have a backup communication system other than cell phones and/or radios?
4) Did you use wireline communications as a backup and did they function properly?
5) What recommendations do you have to improve communications before, during, and after the hurricane(s)?

Appendix B

Districts' Repair Cost Spreadsheets and Reports

Florida's Turnpike Enterprise – Traffic Operations Office
Hurricane ITS Device Replacement Estimates

ITS Devices Damaged During Hurricane Charley – Replacement Costs						
Location	**Device**	**Part Number**	**Equip. Replacement Cost**	**No. of Hours**	**Labor Cost**	**Total Cost**
Orlando South Microwave Tower	Vicon Camera	S2RW23	$3,300.00	4	$600.00	$3,900.00
Jupiter Microwave Tower	Vicon Camera	S2RW23	$3,300.00	4	$600.00	$3,900.00
Varible Message Sign DMS 246	Smart Power Supply	323211-401	$2,013.00	6	$900.00	$2,913.00
		Total	$8,613.00		$2,100.00	**$10,713.00**

Turnpike ITS Devices Damaged During Hurricane Frances – Replacement Costs						
Location	**Device**	**Part Number**	**Equip. Replacement Cost**	**# Hours**	**Labor Cost**	**Total Cost**
Orlando South Microwave Tower	Vicon Camera	S2RW23	$3,300.00	4	$316.00	$3,616.00
Canoe Creek Microwave Tower	Vicon Camera	S2RW23	$3,300.00	4	$316.00	$3,616.00
FHP Camera	Vicon Camera	S2RW23	$3,300.00	4	$316.00	$3,616.00
Varible Message Sign DMS 119	DMS Controller Unit	FP9600	$5,988.00	4	$316.00	$6,304.00
Varible Message Sign DMS 114	DMS Controller Unit	FP9600	$5,988.00	4	$316.00	$6,304.00
Varible Message Sign DMS 196	Smart Power Supply	323211-401	$2,013.00	10	$790.00	$2,803.00
HAR Beacon MP129 N/B	Leds, Charger, Flasher, Battery, Pager, Support Posts, Bases, Enclosures		$11,628.00	25	$1,975.00	$13,603.00
Parts Markup		10%	$2,561.70			$2,561.70
		Total	**$38,078.70**		**$4,345.00**	**$42,423.70**

Turnpike ITS Devices Damaged During Hurricane Jeanne – Replacement Costs						
Location	**Device**	**Part Number**	**Equip. Replacement Cost**	**# Hours**	**Labor Cost**	**Total Cost**
Varible Message Sign DMS 51	DMS Controller Unit	FP9600	$5,988.00	4	$316.00	$6,304.00
Varible Message Sign DMS 256	Smart Power Supply	323211-401	$2,013.00	10	$790.00	$2,803.00
HAR Beacon MP224 N/B	Leds, Charger, Flasher, Battery, Pager, Support Posts, Bases, Enclosures		$11,628.00	25	$1,975.00	$13,603.00
HAR Transmitter @ Stuart	Transmitter Antenna		$1,145.00	4	$316.00	$1,461.00
Parts Markup		10%	$2,077.40			$2,077.40
		Total	**$22,851.40**		**$3,397.00**	$**26,248.40**

FDOT District 5 Emergency ITS System Repair Costs

D5 Emergency ITS System Repairs – Hurricane Charley			
			Total
Contract H5019	ACS	$	31,477.59
Contract H5017	Mastec	$	21,880.68
Contract H5016	TCD	$	72,419.94
	Total	**$**	**125,778.21**

D5 Emergency ITS System Repairs – Hurricane Frances			
			Total
Contract H5054	ACS	$	48,317.85
Contract H5055	Mastec	$	56,769.14
Contract H5056	TCD	$	14,972.48
	Total	**$**	**120,059.47**

D5 Emergency ITS System Repairs – Hurricane Jeanne			
			Total
Contract H5102	ACS	$	2,927.72
Contract H5103	Mastec	$	31,601.90
	Total	**$**	**34,529.62**

FDOT D4
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE FRANCES

Fee Proposal Breakdown for Consultant:

PB FARRADYNE, A DISTRICT OF PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
3201 W. Commercial Blvd., Suite 230
Ft. Lauderdale, FL 33309
Contact Person: Robert Murphy
Telephone: (954) 714-8081

Summary of Additional Budget Requested	
Alltech Operators Unbudgeted Time	2,986.38
Mastec Equipment Relocation Related Items	57,961.50
PB Coordination and Equipment Relocation Assistance	4,845.94
Equipment Damage	5,733.15
Total	**71,526.97**

Fee Proposal Breakdown for Consultant:

PB FARRADYNE, A DISTRICT OF PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

3201 W. Commercial Blvd., Suite 230

Ft. Lauderdale, FL 33309

Contact Person: Robert Murphy

Telephone: (954) 714-8081

TABLE 1 – ALLTECH OPERATORS UNBUDGETED TIME

Labor for Unbudgeted Operators Time (Note 3)

Day	Date	# Hours Worked	# Hours Currently Budgeted	# Hours Requesting Budget For	Raw Category Rate	Multiplier	Burdened Rate	Burdened Costs	Premium Rate	Premium Costs	Totals
Helena White -- Supervisor											
Saturday	2004-09-04	16	8	8	25.23	1.965600	49.59	**396.74**	12.62	**100.92**	
Sunday	2004-09-05	16	8	8	25.23	1.965600	49.59	**396.74**	12.62	**100.92**	
Monday	2004-09-06	16	8	8	25.23	1.965600	49.59	**396.74**	12.62	**100.92**	
Tuesday	2004-09-07	16	8	8	25.23	1.965600	49.59	**396.74**	12.62	**100.92**	1,990.63
Jason Bryant -- Supervisor											
Wednesday	2004-09-08	10	8	2	25.23	1.965600	49.59	**99.18**	12.62	**25.23**	124.41
Senior Operators											
Saturday	2004-09-04	16	8	8	17.67	1.965600	34.73	**277.86**	8.84	**70.68**	
Sunday	2004-09-05	26	16	10	17.67	1.965600	34.73	**347.32**	8.84	**88.35**	
Wednesday	2004-09-08	10	8	2	17.67	1.965600	34.73	**69.46**	8.84	**17.67**	871.34
TOTAL ALLTECH											**2,986.38**

Note 3: These Employees are Burdened at Overhead Rate 75.5%, FCCM Rate 0%, Margin Rate 12%.

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE FRANCES

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TABLE 2 – MASTEC EQUIPMENT RELOCATION RELATED ITEMS

Labor for Equipment Relocations

Day	Date	# Employees	Hours Each Worked	Hours Sub-total	Hourly Rate	Costs	Totals
Thursday	2004-09-02	11	8.5	93.5	105.00	9,817.50	
Monday	2004-09-06	1	10.0	10.0	105.00	1,050.00	
Tuesday	2004-09-07	3	6.5	19.5	105.00	2,047.50	
Wednesday	2004-09-08	4	10.5	42.0	105.00	4,410.00	
Thursday	2004-09-09	4	9.0	36.0	105.00	3,780.00	
Friday	2004-09-10	3	7.5	22.5	105.00	2,362.50	
Monday	2004-09-13	2	6.5	13.0	105.00	1,365.00	
Monday	2004-09-20	1	11.0	11.0	105.00	1,155.00	
Tuesday	2004-09-21	1	3.0	3.0	105.00	315.00	
Wednesday	2004-09-22	1	4.0	4.0	105.00	420.00	
Thursday	2004-09-23	1	9.0	9.0	105.00	945.00	27,667.50
Equipment Relocations				# Items	Rate	Costs	Totals
O&M Item # 700-89-3A (ITS SmartZone Relocation)				2.0	4,185.00	8,370.00	
O&M Item # 700-89-4A (Portable DMS Relocation)				9.0	2,436.00	21,924.00	30,294.00
TOTAL MASTEC EQUIPMENT RELOCATION RELATED ITEMS							**57,961.50**

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TABLE 3 – PB COORDINATION & ASSISTANCE IN EQUIPMENT RELOCATION RELATED ITEMS
Labor for Coordination of Equipment Relocations

Day	Date	# Hours Worked	# Hours Currently Budgeted	# Hours Requesting Budget For	Raw Category Rate	Multiplier	Burdened Rate	Costs	Totals
Michael Grant -- Field Engineer (Note 1)									
Thursday	2004-09-02	10	4	6	32.02	2.375204	76.05	456.32	
Friday	2004-09-03	10	4	6	32.02	2.375204	76.05	456.32	
Monday	2004-09-06	10	0	10	32.02	2.375204	76.05	760.54	
Tuesday	2004-09-07	10	4	6	32.02	2.375204	76.05	456.32	
Wednesday	2004-09-08	10	4	6	32.02	2.375204	76.05	456.32	2,585.84
Bob Murphy -- PM (Note 1)									
Monday	2004-09-06	8	0	8	47.36	2.375204	112.49	899.92	899.92
James Lou -- Field Engineer (Note 2)									
Thursday	2004-09-02			3	32.02	2.831940	90.68	272.04	
Friday	2004-09-03			0	32.02	2.831940	90.68	0.00	
Monday	2004-09-06			4	32.02	2.831940	90.68	362.71	
Tuesday	2004-09-07			4	32.02	2.831940	90.68	362.71	
Wednesday	2004-09-08			4	32.02	2.831940	90.68	362.71	1,360.18
TOTAL PB									**4,845.94**

Note 1: This Employee is Burdened at Field Office Overhead Rate 111.67%, FCCM Rate .45%, Margin Rate 12%.
Note 2: This Employee is Burdened at Home Office Overhead Rate 152.45%, FCCM Rate .45%, Margin Rate 12%.

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE FRANCES

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TABLE 4 – EQUIPMENT DAMAGE

	Part #	# Items	Unit Price	Costs	Totals
Battery/Equipment Compartment "Goal Wing" Covers for Left (Devices 42,46,48)	001-3606	3	192.84	578.52	
Battery/Equipment Compartment "Goal Wing" Covers for Right (Devices 42,46,48)	001-3610	3	192.53	577.59	
Camera Dome Housings from SmartZones	706-1000	3	235.05	705.15	
Electric Winch (12v) for SmartZone #26	001-5079	1	783.05	783.05	
Pager Modem	USR5686ECCS	1	105.99	105.99	
Yaggi Antenna	001-4940	5	596.57	2,982.85	
TOTAL EQUIPMENT DAMAGE					**5,733.15**

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
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Summary of Additional Budget Requested	
Alltech Operators Unbudgeted Time	2,308.28
Mastec Equipment Relocation Related Items	41,707.50
PB Coordination and Equipment Relocation Assistance	3,194.27
Equipment Damage	44,489.71
Total	**91,699.76**

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE JEANNE

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TABLE 1 – ALLTECH OPERATORS UNBUDGETED TIME

Labor for Unbudgeted Operators Time (Note 3)

Day	Date	# Hours Worked	# Hours Currently Budgeted	# Hours Requesting Budget For	Raw Category Rate	Multiplier	Burdened Rate	Burdened Costs	Premium Rate	Premium Costs	Totals
Helena White -- Supervisor											
Saturday	2004-09-25	10.0	8.0	2.0	25.23	1.965600	49.59	**99.18**	12.62	**25.23**	
Sunday	2004-09-26	12.0	8.0	4.0	25.23	1.965600	49.59	**198.37**	12.62	**50.46**	
Monday	2004-09-27	14.0	8.0	6.0	25.23	1.965600	49.59	**297.55**	12.62	**75.69**	746.49
Jason Bryant -- Supervisor											
Saturday	2004-09-25	8.5	8.0	0.5	25.23	1.965600	49.59	**24.80**	12.62	**6.31**	
Sunday	2004-09-26	16.0	8.0	8.0	25.23	1.965600	49.59	**396.74**	12.62	**100.92**	
Monday	2004-09-27	12.0	8.0	4.0	25.23	1.965600	49.59	**198.37**	12.62	**50.46**	777.59
Senior Operators											
Monday	2004-09-27	16.0	8.0	8.0	17.67	1.965600	34.73	**277.86**	8.84	**70.68**	
Tuesday	2004-09-28	26.0	16.0	10.0	17.67	1.965600	34.73	**347.32**	8.84	**88.35**	784.21
TOTAL ALLTECH											**2,308.28**

Note 3: These Employees are Burdened at Overhead Rate 75.5%, FCCM Rate 0%, Margin Rate 12%.

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
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TABLE 2 – MASTEC EQUIPMENT RELOCATION RELATED ITEMS
Labor for Equipment Relocations

Day	Date	# Employees	Hours Each Worked	Hours Sub-total	Hourly Rate	Costs	Totals
Friday	2004-09-24	5	10.0	50.0	105.00	5,250.00	
Sunday	2004-09-26	1	7.0	7.0	105.00	735.00	
Monday	2004-09-27	1	13.5	13.5	105.00	1,417.50	
Tuesday	2004-09-28	5	8.0	40.0	105.00	4,200.00	
Wednesday	2004-09-29	5	7.0	35.0	105.00	3,675.00	
Thursday	2004-09-30	1	7.5	7.5	105.00	787.50	
Friday	2004-10-01	1	8.0	8.0	105.00	840.00	
Saturday	2004-10-02	1	6.0	7.0	105.00	735.00	
Monday	2004-10-04	2	6.5	13.0	105.00	1,365.00	
Tuesday	2004-10-05	3	3.5	10.5	105.00	1,102.50	
Wednesday	2004-10-06	1	10.0	10.0	105.00	1,050.00	21,157.50
Equipment Relocations				# Items	Rate	Costs	Totals
O&M Item # 700-89-3A (ITS SmartZone Relocation)				2.0	4,185.00	8,370.00	
O&M Item # 700-89-4A (Portable DMS Relocation)				5.0	2,436.00	12,180.00	20,550.00
TOTAL MASTEC EQUIPMENT RELOCATION RELATED ITEMS							**41,707.50**

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE JEANNE

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TABLE 3 – PB COORDINATION & ASSISTANCE IN EQUIPMENT RELOCATION RELATED ITEMS
Labor for Coordination of Equipment Relocations

Day	Date	# Hours Worked	# Hours Currently Budgeted	# Hours Requesting Budget For	Raw Category Rate	Multiplier	Burdened Rate	Costs	Totals
Michael Grant -- Field Engineer (Note 1)									
Friday	2004-09-24	13	4	9	32.02	2.375204	76.05	684.49	
Sunday	2004-09-26	5	0	5	32.02	2.375204	76.05	380.27	
Monday	2004-09-27	12	4	8	32.02	2.375204	76.05	608.43	
Tuesday	2004-09-28	11	4	7	32.02	2.375204	76.05	532.38	
Wednesday	2004-09-29	11	4	7	32.02	2.375204	76.05	532.38	
Thursday	2004-09-30	10	4	6	32.02	2.375204	76.05	456.32	3,194.27
James Lou -- Field Engineer (Note 2)									
					32.02	2.831940	90.68	0.00	
					32.02	2.831940	90.68	0.00	0.00
TOTAL PB									**3,194.27**

Note 1: This Employee is Burdened at Field Office Overhead Rate 111.67%, FCCM Rate .45%, Margin Rate 12%.
Note 2: This Employee is Burdened at Home Office Overhead Rate 152.45%, FCCM Rate .45%, Margin Rate 12%.

FLORIDA DEPARTMENT OF TRANSPORTATION, DISTRICT FOUR
PALM BEACH COUNTY INTERIM TRAFFIC MANAGEMENT SYSTEM (ITMS)
FM # 411067 1 32 01 and 411067 1 82 01
ADDITIONAL COSTS DUE TO HURRICANE JEANNE

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TABLE 4 – EQUIPMENT DAMAGE

	Part #	# Items	Unit Price	Costs	Totals
DMS Power Inverter		1	1,000.00	1,000.00	
Portable DMS		4	10,000.00	40,000.00	
Portable Generator		3	300.00	900.00	
Solar Panel Mechanism		1	800.00	800.00	
Yaggi Antenna	001-4940	3	596.57	1,789.71	
TOTAL EQUIPMENT DAMAGE					**44,489.71**

TRAFFIC ENGINEERING OFFICE

Field Damage Assessment

For

Traffic Signal Equipment and Supports

Resulting from Hurricane Charley

August 31, 2004

H. Eric Larson, P.E.

Traffic Systems Studies Engineer

A field study was conducted by the Traffic Engineering Office to assess the damage that was caused by Hurricane Charley on traffic equipment and support structures. Hurricane Charley made land fall on August 13, 2004 in the Punta Gorda/Port Charlotte area of southwest coast of Florida. Charley was reported to have sustained winds of 145 MPH at landfall. The hurricane then traveled northeast passing near of Orlando and continued northeast out into the Atlantic Ocean. The field study first observed tree and brush damage along Interstate 75 Southbound approximately 20 miles north of Port Charlotte and Punta Gorda interchanges on I-75. Damage severity of trees and structures increased as we proceeded south on I-75. We exited at interchange 164 for State Road 17 which proceeds west into Punta Gorda. US17 Travels west into Punta Gorda and is a two lane one way street named Marion Avenue. The eastbound SR-17 is a two lane one way roadway one block south of Marion Ave and is named Olympia and travels back toward I-75.

The Departments current policy for mast arm traffic signal supports requires that mast arm shall be used on all state road projects within 10 miles of the coast line. Many current projects are installing mast arm traffic signal supports on projects further inland than 10 miles as determined by the district offices.

The following photos detail the general condition of the signals and associated support and mounting hardware at specific locations as noted for each photograph. The mast arm signal supports did survive significantly better than the strain pole/span wire configuration.

A summary and a damage assessment is provided at the end of this study.

Figure B.1

This is the intersection of Marion (SR 17 South) and U.S. 41 in downtown Punta Gorda. The signal heads and back plates have no obvious damage. The mast arm supports at this intersection have no apparent damage.

Figure B.2

This is at Marion Avenue looking south on U.S. 41. There is no apparent damage to either the mast arm supports or signal head assemblies. Notice the temporary STOP signs that are mounted on barricade panels at the intersection.

Figure B.3

This is southbound on U.S. 41 at the intersection of Olympia. The mast arm and signal assemblies appear to have minimal damage. The NO RIGHT TURN sign panel on the mast arm was skewed as a result of high winds.

Figure B.4

This is eastbound on Olympia (SR 17), one block east of SR 41. There appears to be signal head and back plate damage, but no apparent mast arm damage. Miscellaneous downed utility wires can be seen in the background.

Figure B.5

This was taken proceeding eastbound on Olympia (SR 17) at Nesbit intersection. The signal head has been rotated on the mounting bracket. There is no apparent damage to the mast arm support or traffic signals.

Figure B.6

This is the eastbound view on SR 17 at the I-75 interchange. The signal heads are missing with their mounting hardware. The remaining signal heads are skewed as a result of high wind forces. Notice the leaning high mast lighting support in the left center of the photograph. Most high mast lighting supports failed at this I-75 interchange.

Figure B.7

This is the I-75 southbound off ramp at the SR 17 intersection. The vehicle is traveling westbound on SR 17 towards Punta Gorda. The signal heads shifted and are skewed with no apparent mast arm damage.

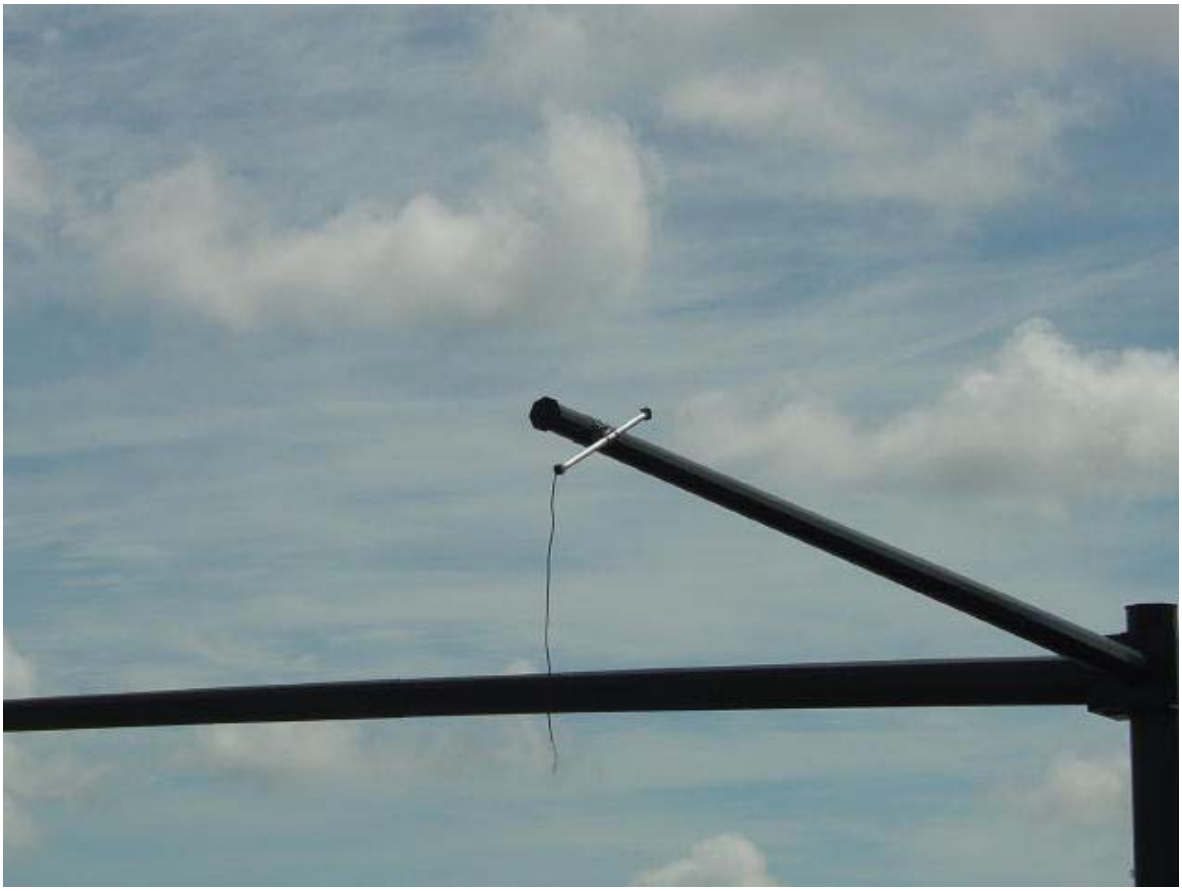


Figure B.8

This is the southbound I-75 exit at SR 17. The signals are gone with their mounting hardware. The remains of one signal head mounting bracket is still attached. There is no apparent mast arm damage.

Figure B.9

The photograph depicts an early design mast arm failure at SR17 leaving Punta Gorda.

Figure B.10

The photograph depicts an early design mast arm failure on SR 17 westbound at the I-75 interchange. The sign panel is rotated 90 degrees from its original position.

Figure B.11

This is a sign support structure failure at I-75 and SR 17.

Figure B.12

Figures B.11 and B.12 are sign structure failures on the SR 17 eastbound and I-75 interchange. Notice the mounting plate distortion. The weld connection on the arm plate did not fail.

Figure B.13

This is the sign support structure failure at the I-75 and SR 17 interchange, traveling northbound.

Figure B.14

This depicts better detail of the sign structure footer failure.

Figure B.15

See Figure B.16.

Figure B.16

Figures B.15 and B.16 depict span wire failures at an intersection one mile north of I-75 traveling northbound on SR 17. Notice the numerous adjustable hanger failures.

Figure B.17

The signal head has been separated from the mast arm structure in Arcadia, Florida, traveling northbound on SR 17.

Figure B.18

See Figure B.19.

Figure B.19

Figures B.18 and B.19 are a diagonal strain pole support with the entire strain wire assembly gone at Main Street in Bowling Green, Florida, northbound on SR 17.

Figure B.20

This illuminated street sign on John Young Parkway in Orlando shows the front side of the sign where the street name should appear.

Figure B.21

This is the rear view of a damaged, illuminated street sign on John Young Parkway. Notice that the rear panel and street name panel are missing, yet the florescent lamps survived the wind forces.

Study Summary:

Field observations were made starting in Punta Gorda, Florida and proceeding up SR-17 to I-4 and the Orlando area to assess hurricane damage to traffic signals and signal support structures. The observations indicated that the mast arm support structures survived with little or no damage. Signal heads were in some cases completely gone from the arm assembly. Some signal heads were skewed or rotated on their support brackets but were still attached to the arm. Signal back plates were damaged in some cases as shown in the proceeding photographs. I did not observe any mast arm assembly rotational movement along the roadway under study.

Traffic signal strain pole span wire assemblies did not survive as well as the mast arm assemblies. As shown in the photographs signal heads were missing, disconnect hangers were missing in some cases and numerous adjustable hangers failed due to the extreme wind loading on the signal head assembly. In several cases the entire span wire assembly between the strain poles was down. My observations did not show any concrete strain pole failures only signal span failures.

Strain pole span wire installations were damaged as far inland as Orlando. An illuminated street sign assembly on John Young Parkway in Orlando had its name panel and back panel blown away but the two florescent bulbs survived, see photograph 21.

Several hundred more photographs were taken during the field study which provides photographs of structure failures of numerous signing and high mast lighting assemblies.

Conclusions:

The traffic signal mast arm support technology survived significantly better than did the strain pole strain wire span design. Mast arm and strain pole installations were located only blocks from each other along the study route and the mast arm survivability was very apparent.

Portable DMS #44 – Okeechobee Road east of Australian Avenue –
West Palm Beach, Florida – September 28, 2004

Photos from Parsons Brinckerhoff, Fort Lauderdale

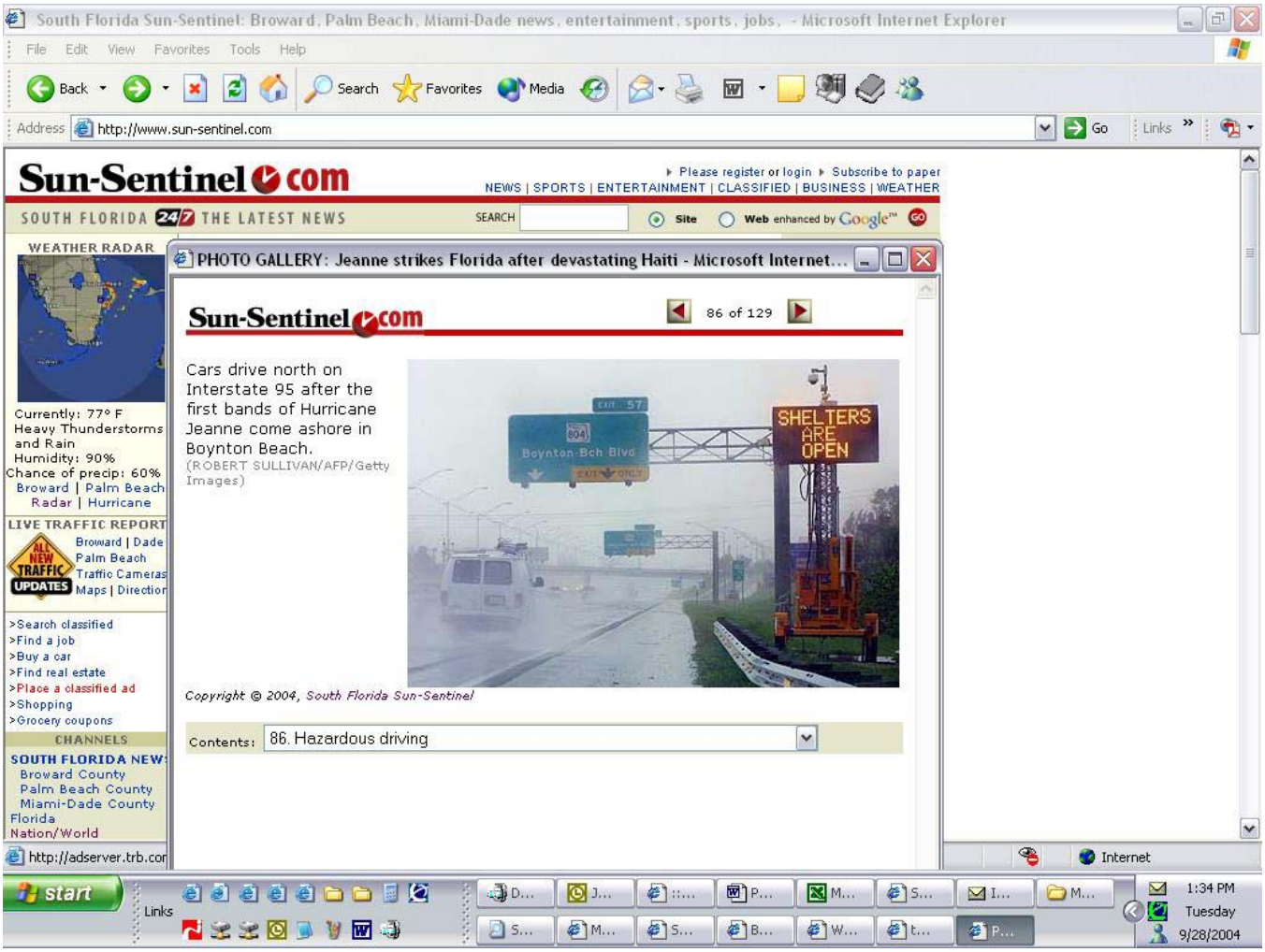
Portable DMS #53 – Hypoluxo Road west of U.S. 1 –
Hypoluxo, Florida – September 29, 2004

DMS #32 – Donald Ross Road east of I-95 –
Jupiter, Florida – September 28, 2004

DMS #52 – Congress Avenue south of 6th Avenue –
Lake Worth, Florida – September 27, 2004

Camera dome assemblies that were removed from
SmartZones during Hurricane Jeanne –
September 24-26, 2004

SmartZone #10 retracted prior to dome removal –
I-95 southbound south of Palm Beach Lakes Boulevard –
West Palm Beach, Florida – September, 24, 2004



Fort Lauderdale's Sun-Sentinel newspaper featured a photograph of an ITMS electronic message sign just prior to Hurricane Jeanne – Saturday, September 25, 2004